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INDUSTRIAL ORGANISATION AS A CREATIVE SOCIAL INSTITUTION

THE debate on joint consultation in industry in the House of Commons on April 5 was certainly less superficial than most current discussions on this subject, though the real issues were not entirely disclosed. It was recognized that the object of joint consultation is to create real partnership, and that part of the problem is to establish the right atmosphere and to remove the suspicions which have thwarted efforts at co-operation and consultation in the past. Mr. E. Fernyhough, in opening the debate, referred to the importance of helping the worker to feel that he is part and parcel of the establishment where he works and that his views on all matters will be taken into consideration. He referred also to the importance of developing a sense of responsibility, and he and Major W. F. Vernon, who seconded the amendment, stressed the importance of full information about the operations of a business, including its financial situation, being made available as a basis for consultation. Other speakers also stressed the importance of this point and its bearing on cultivating a new attitude towards production and productivity; Mr. R. J. Gunter pointed to the absence of real research departments as one of the weaknesses in the trade union movement to-day.

Mr. Gunter perhaps went nearer to one of the fundamental issues than the House appeared to realize, and later in the debate Mr. J. A. Boyd-Carpenter emphasized that there are limits to what joint consultation can do. It is, as Sir Peter Bennett had earlier suggested, not a substitute for efficient management but a useful adjunct, provided we recognize its limitations and have clear ideas as to the real functions joint consultation can perform. Mr. Boyd-Carpenter's warning gained the more from his stress on its social implications, its contribution towards helping men to find satisfaction in their work and towards increased efficiency, because men could come to understand through it the purpose of their work, how it fits into the whole pattern of their industry and how that industry fits into the national pattern.

Nevertheless, despite all the recognition of past weaknesses and failures, scarcely anyone in this debate ventured to point out the corollaries and the positive action required to avoid the repetition of failures and weaknesses of the past. There was no clear statement as to what exactly is involved by the new outlook that is obviously required both in the trade unions and on the side of employers. Several speakers recognized that joint consultation must include the manager and other professional workers, scientific or technical; but no one faced the place and contribution of such workers as frankly as Prof. J. W. Cook, regius professor of chemistry in the University of Glasgow, did only a few days previously in his presidential address to the Royal Institute of Chemistry.

Prof. Cook referred to the concern of the Council of the Institute at the pressure which is being put on chemists to join trade unions, particularly in the

nationalized industries. He suggested that for chemists as a body to yield to this pressure to join trade unions would amount to a tacit acquiescence in the doctrine of equalitarianism, and an acceptance of the view that professional men and women should be classified socially and economically with the great body of manual workers. Even if all chemists were to join a professional body, registered as a trade union like the British Association of Chemists, such a relatively small scientific trade union would be comparatively impotent compared with the numerically large bodies representing industrial workers. The position would not be greatly different if chemists were to join with other scientific men in the Association of Scientific Workers; and there is already experience from the nationalized industries to support Prof. Cook's warning that such a scientific trade union might in time be swallowed up by one of the larger bodies.

The issue Prof. Cook has raised here is far wider than that of the prestige of the Royal Institute of Chemistry, with which his presidential address was immediately concerned. It is a question of how professional bodies can best serve the economic and wider interests of their members in the social security State. Circumstances to which Prof. Cook did no more than allude suggest that the reasons which thirty years ago led the British Association of Chemists, for example, to register as a trade union, may no longer have the same force. It is at least arguable whether to-day a body of professional men can serve their own economic interests or the interests of the general society of which they are members by registering as a trade union. They might, it is true, set an example to the trade unions in general of the new outlook and the new methods that are required to-day to serve the interests alike of members and of society. There is no warrant for optimism as to that example being effective; and even if it were, the suggestion that professional men might promote the introduction of a new spirit more effectively in some other way cannot be dismissed without examination.

It needs no more than the recurrent disputes among the dockers unions to demonstrate that the gravest dangers to industrial peace to-day lie in the failure of the trade unions to adjust their conceptions of their functions to the new conditions, and the persistence of archaic and obsolete practices and habits of thought. The lessons which Gertrude Williams sought to teach six years ago in "The Price of Social Security" are still largely unlearned. Until there is evidence that they have been learnt by the trade unions generally, professional men may well be entitled to hold that they can make their contribution to industrial peace rather by co-operation as a third party than by merging themselves with the trade unions generally.

The first need is for clear thinking about the place and functions of trade unions and professional associations under the new conditions and for the discarding of obsolete inhibitions. That involves, of course, a long course of education of opinion; but neither the task of education nor the constructive thinking can proceed until the facts of the situation are recognized. It is especially for his facing of these facts and his analysis of their implications that Mr. H. Somervell's recent book* is most welcome. He offers, moreover, some suggestions or formulæ for industrial co-operation and the elimination of disputes, though he does not claim that they are the only solutions of the problem of industrial peace. He does, however, indicate the principles upon which any solution must be based, and the changes that must be made if effective industrial co-operation is to be possible.

It should not be thought that, particularly on the side of organisation, all, or even most, that Mr. Somervell stresses is new. There he has clearly drawn largely on the ideas of Col. L. Urwick and Mary Follett and other thinkers of the past quarter of a century and more, as the recently published lectures in business organisation, "Freedom and Co-ordination" of M. P. Follett†, illustrate. The basis of industrial co-operation, as Elton Mayo pointed out in his introduction to those lectures, is clearly set forth by Mary Follett, and Mr. Somervell's book is essentially an amplification and application of her principles. Her insistence that we need most to study the growth of a decision and the accumulation of authority, not the final step, the location of knowledge and experience with authority, and the view that organisation should have for one of its chief aims the provision for a joint authority where combined knowledge is necessary for the best judgment, find their counterpart in Mr. Somervell's book. Like Mr. Somervell, but twenty-three years earlier, dealing with the necessity for studying and understanding how the separate elements or constituents of an organisation interact, she both insists that the unified activities of the organisation depend not on the constituents alone, but also on how they are related and interact, and she records the view that the great weakness of the British Labour Party is its failure to recognize just this relating of parts, the co-functioning organic inter-activities, as essential in a democracy.

Miss Follett's observations on the giving of orders, by depersonalizing orders and bringing out what she terms the demand of the situation and the contribution which management might here make in solving the problems of human relations, and thereby the greater problems of co-ordination and control upon which future progress depends, also point the way to the solutions Mr. Somervell outlines. Her analysis of authority, with its note of thinking in terms of responsibility for definite tasks, the linking of authority firmly with the job, and the belief that true freedom is only gained by an understanding of the process by which authority is generated and that genuine authority is the outcome of our common life, are reflected in the principles laid down by Mr. Somervell. Further, her belief that business men should train themselves as professional men to take a creative part in this large function of society and her emphasis on the need for finding by a process of

* Industrial Peace in Our Time. By Hubert Somervell. Pp. xiv + 224. (London: George Allen and Unwin, Ltd., 1950.) 15s. net.

† Freedom and Co-ordination: Lectures in Business Organisation. By Mary Parker Follett. Edited, with an Introduction, by L. Urwick. Pp. xvii + 89. (London: Management Publications Trust, Ltd., 1949.) 5s. net.

integration a way in which the opinion of the expert does not coerce but yet enters integrally into the situation, and her whole view of co-ordination, are also part of the thesis upon which Mr. Somervell builds up a basis for any main system of remuneration intended to express the social partnership status of labour in industry, and even the very foundations of a new industrial society.

Mr. Somervell firmly rejects the obsolete idea that labour is a commodity, and with it all the practices and systems based on that idea. Association for industrial production, he argues, requires a partnership type of organisation, in which all the partners or contributors, whether employers or employees, managers or manual workers, not only retain their independence and share both in the control and in the proceeds of the joint enterprise, but also are conscious of belonging to the enterprise. The organisation required should be built up around the finished product, which is the material result of such association, and not, as was usual in the past, around the profits.

Mr. Somervell is very careful not to undervalue the significance of any of the three main contributions to the industrial process; even self-interest is not thrown out in the discard, and he recognizes that the profit motive has its place from that point of view, and also as a measure of efficiency and a source for financing expansion and risk. His comments on the weaknesses and shortsightedness of trade unions to-day do not prevent him from stressing the very important contribution that the trade unions have to make in establishing a new industrial society. The decentralization he advocates is intended to give the unions fresh vitality, by developing strong local unions, which derive more strength from national affiliation or federation, not to undermine their influence, even if their functions to day have changed. This, he believes, is the only way in which the present vast structure can avoid disaster. Equally he stresses the reality of the management function, the importance of which is enhanced rather than diminished by the movement towards functional instead of financial control.

At the root of Mr. Somervell's proposals lies his conception of industrial organisation as a creative social institution, providing public service as well as a field in which every individual has the maximum opportunity for developing his gifts and so living a full, satisfying and useful life, and creating institutions which contribute to social stability and creative civilization. Accordingly he postulates, as already indicated, that the contributors to the industrial process, while separate and distinct, one providing the means, another the work and the third uniting both in the provision of organisation or management, all belong to the enterprise and to each other. Further, as all share in producing the finished product, so they should share in the values of its disposal; and the relations between the groups should be built around the central function of management in a balanced form of obligations towards workers in one direction and towards shareholders in the other. In organisation, the goal should be decentralization, and since industry is primarily concerned with the organisation of people, not machinery, there should be no hesitation in appealing to moral considerations, the basic moral value being justice, not charity. Recognition of this with, as corollary, a shift of obligation on the part of management from shareholder to worker, provides the basis of a system of equitable control in which management retains its full distinctive function.

The examples which Mr. Somervell gives of experiments along these lines are of interest chiefly as illustrations of the practicability of remunerating labour by its share of production, and as pointers to the principles on which any such system must be based. These, Mr. Somervell contends, are few: labour is entitled to the whole value of its contribution to production; double incentives, group and personal, must be provided; a regular weekly salary; and participation of the workers in the control of the administration of their contributory function, with joint consultation accordingly in all decisions which influence the remuneration of labour. The emphasis is on fact-finding and full information as a road to agreed decisions, with all parties satisfied that the decision and policy are reasonable and in accordance with the demands of the situation.

However much it may be possible to improve on the particular schemes which Mr. Somervell describes, experience with them already demonstrates that, given the right conditions, co-operation can be secured on such lines, and apparently conflicting interests aligned. Moreover, there are possibilities of eliminating some of the excessive rigidity which hampers industry in its adjustment to changing conditions. Nor does Mr. Somervell leave us in any doubt that what is chiefly required from the State is what has in post-war years been sadly lacking, namely, initiative and not dictation, education without propaganda, the use of tradition and experience as the springboard for encouraging originality, regulation rather than management, and planning and design without impairing execution outside political circles. He is convinced that if the State claims unlimited obligations from, and control over, those who perform the managerial and labour functions, it will merely perpetuate one of the evils of the nineteenth century—the belief that control can only be vested through ownership.

Mr. Somervell challenges many accepted beliefs and practices; but before his premises are rejected, some fundamental thinking is required of his critics. The trade unionist cannot dismiss his argument for decentralization and less rigidity without advancing an alternative means of dealing with admitted evils. The manager or technician must show a better alternative way of doing things with his workers rather than to them. The State, too, must show clearly how its joint consultation schemes will meet the tests indicated by Mr. Somervell, and must not be content to ignore the challenge which their comparative failure in certain conspicuous fields constitutes. Also, the fairness with which Mr. Somervell deals with the alignment of the capital interests should lead those who may be primarily concerned

as shareholders to think long and deeply before they reject proposals which promise to deal so fairly with their interest in a society which is becoming increasingly organised upon a democratic ideal of public service through private enterprise. At the least, Mr. Somervell's book should strip some of the woolliness from our thinking about industrial relations, and contribute towards a new constructive alignment of all groups participating in production or commercial enterprise, in which both economic and social purposes are fulfilled, and men and women can understand how their work is serving the community of which they are themselves a part.

HELMHOLTZ'S THEORY OF HEARING UNDER VOLLEY FIRE

Theory of Hearing

By Prof. Ernest Glen Wever. (Wiley Publications in Psychology.) Pp. xiii+484. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1949.) 48*s*. net.

THE field of the special senses is a 'Tom Tiddler's ground' intruded on by prospectors from a dozen neighbouring territories of scientific study, each with its own techniques and its own language. A lingua franca has yet to be worked out. It is difficult at present for the zoologist to understand the findings of the clinician, for the psychologist to understand the physicist, and for the engineer to understand the anatomist; and a complacent misunderstanding is fatally easy, particularly about hearing. So it is not surprising that, although an appalling amount of nonsense has been written and published about auditory theory, books on it which are at once synthetic and authoritative and intelligible are few and far between. It is twelve years since "Hearing" by Hallowell Davis and S. S. Stevens set a very high standard. It can be surmised that this book gained enormously in clarity from the collaboration of a medically qualified physiologist with a psychologist. Its weaknesses were on the physical and comparative sides; but within its limitations it was well arranged, exhaustive and very readable.

Now another psychologist has attempted a synthesis. Prof. E. G. Wever ought to be eminently qualified for the task: it was his discovery with C. W. Bray twenty years ago of the effect still known by their names which gave a new impetus to the physiological study of the ear. Moreover, he is one of the few men of science who have inquired into the auditory capabilities of animals, and who might in consequence have escaped the narrowly anthropocentric attitude which misled even Helmholtz and has been a curse to the subject ever since. Here surely should be the balanced and up-to-date survey we have been waiting for.

This anticipation is not altogether fulfilled. Of the three parts into which the book is divided, the first is a useful and comprehensive, but rather uncritical, survey of the history of auditory theory. The second part attempts to evaluate the principal theories by setting them in relation to the facts of observation. The argument is here weakened and diluted by the author's failure to distinguish problems peculiar to auditory theory from general problems of perception. When he says, for example, that Gray's principle of maximal stimulation "saved the day" temporarily for the resonance theory, he is introducing a red herring. It may safely be assumed that a pure tone is heard as a pure tone for the same reasons that a pencil point on the skin is felt as a single point, although in both cases many receptors are excited in differing degree. What these reasons are is, no doubt, a problem; but it is not specifically an auditory problem, and it does not affect the validity of the resonance theory either way. The objections here raised to the resonance theory all vanish like mist before the sun of a critical examination, and not all of them are correctly stated or based on established fact. It is difficult not to believe that the author has deceived himself as to their weight in his devotion to his own volley theory, the development of which occupies the third and by far the largest part of the book.

The essence of the volley theory is that a judgment of pitch depends not only on the particular fibres in the auditory nerve which are excited by a tone, but on a particular temporal relation between the impulses in these fibres and the sound waves impinging on the tympanic membrane. For middle and lower frequencies, the second factor is considered to be predominant. In my opinion, this theory is redundant, but there is nevertheless in this part of the book a valuable compendium of experimental data. In fairness to the author, it must be said that he often allows the facts to speak for themselves and has frequently resisted the ever-present temptation of the theorist to select the evidence which makes his case. But it is not always so. For it is well established that pitch discrimination is at its best at 1–12 kc./s., and in this range is roughly constant at about 1/30 semitone. Below 1 kc./s. the least discriminable interval rises steeply to more than a whole tone at the lowest audible frequencies. But the author on p. 333 says: "It is of interest that in the middle range, where according to the [volley] theory there is both spatial and frequency representation, *the discrimination is no better than in the low range* [my italics] where frequency serves alone. It appears that the frequency cue is so much the more accurate that the presence of the other is of no appreciable benefit to this function." Here, where the facts are destructive of his theory, he has inverted them in its support.

Lapses into obscurity, sporadic throughout the book, become continuous when the author is discussing the physical aspects of hearing. For example, the sentence (p. 37) "No resonance is wholly specific" appears to mean "No resonator has only a single resonant frequency", whereas from the context it can be inferred that the intended meaning is "No (real) resonator is indefinitely selective"—a truism which might well have been omitted. In many other places the obscurity is not dispelled, even by a careful study of the context; and occasionally a blatant error shakes the reader's faith. Fig. 115, ostensibly an oscillogram of the combination of frequencies of 1,000 and 1,001 c./s., is clearly not what it pretends.

But in spite of obvious failings the book is a considerable achievement. It is, in fact, one of the three or four books on hearing published since Helmholtz's time which allow of serious criticism; and, while it is probable that most students of the subject will be amused or exasperated by it according to their temperament, it is also probable that few will be able to afford not to buy it.

R. J. PUMPHREY

PLANETARY ATMOSPHERES

The Atmospheres of the Earth and Planets

Papers presented at the Fiftieth Anniversary Symposium of the Yerkes Observatory, September 1947. Edited by Gerard P. Kuiper. Pp. vii+366+16 plates. (Chicago: University of Chicago Press; London: Cambridge University Press, 1949.). 60*s* net.

ASTROPHYSICS has produced some exciting chapters during the past half-century. One of the latest, and certainly not the dullest, concerns the atmospheres of the planets. Twenty-five years ago the whole subject was still very obscure, while even with the atmosphere of most concern to us, that of the earth, our knowledge was comparatively limited. Since then, by brilliant spectroscopic work in the visible and infra-red, important constituents of the atmospheres of Venus, Mars, Jupiter and Saturn have been identified. We know of abundant carbon dioxide on Venus, but can find little trace of oxygen or water vapour; of smaller quantities of carbon dioxide on Mars, with again extremely little oxygen or water vapour; of methane and ammonia in the major planets, with evidence for ice as a major constituent of the rings and inner satellites of Saturn. More than this, it has been discovered that the spectrum of the polar cap of Mars resembles that of hoar frost, and that the greenish areas on Mars do not show the absorption spectrum of chlorophyll, although it is still possible they may be due to lichens or mosses. The spectrum of the browner areas of this planet has been matched with that of a brownish felsite, but has been shown to be quite different from that of various other terrestrial soils and rocks of about the same colour.

Solid, or at least non-gaseous, particles are present in all planetary atmospheres. Those on Venus are not yet identified; on Mars there is a variable haze which may be similar to very fine cirrus cloud, and quite possibly composed of ice crystals. The clouds on Jupiter and Saturn can be explained as ammonia crystals, in an atmosphere containing much hydrogen. The optical properties of such atmospheres are being linked up with those of the terrestrial atmosphere and even of interstellar space.

But the astronomical discoveries are in a sense only a part of the story, which now involves several other sciences—meteorology, radio physics, geology and even ballistics—and this is specially true of the atmosphere of the earth. This we think of as a complicated heat machine, driven by solar radiation, showing great variability in detail, but apparently of great long-term stability. The evidence available suggests little fundamental change since the beginning of geological time, although in view of the great discrepancies in abundance of individual elements (when compared with the major planets, the sun, stars or nebulæ) present opinion inclines to the belief that our atmosphere is secondary, perhaps in part produced by life itself. Here a paradox is encountered: the atmospheric oxygen of the earth may be chiefly a product of living matter, yet this same oxygen is the principal agent which filters out the lethal ultra-violet from the solar spectrum.

We realize that our pictures of the atmospheres of other planets are excessively simplified (as are most astronomical pictures) by lack of data. On the earth, however, we are familiar with the bewildering complexity of meteorological phenomena in the lower atmosphere, while the study of meteors, of the night-sky spectrum, of auroras, and of the reflexion or transmission of radio waves, shows a no less complicated multi-layer upper atmosphere, its properties controlled by the absorption spectra of various gases, notably oxygen and ozone. We link disturbances in these higher layers with events on the sun, the effects of which are transmitted in part by ultra-violet light and in part by corpuscles the identity of which is still uncertain. Our ideas are now being tested by soundings with rockets, the results so far substantially confirming the picture built up from the other sources just named. These rocket flights are permitting an extension of our direct knowledge of the ultra-violet solar spectrum, which at sea-level is cut off by the atmosphere at about 3000 A. Photographs have been taken of the spectrum down to 2200 A., showing thus far a rapidly weakening continuous spectrum, heavily blanketed by absorption lines. There is as yet no trace of the strong radiation, probably arising in the chromosphere and corona, and of much shorter wavelengths, believed to be responsible for ionospheric disturbances.

Study of our upper atmosphere leads us to the belief that the temperatures there are high, perhaps up to 1,500° K., and this re-opens questions as to the loss of gases from the top of the atmosphere. What is the nature of the equilibrium when atomic collisions become relatively infrequent, and to what extent are there similarities with the outer atmospheres of the sun and other stars?

All these matters, and a great deal more, are discussed in the book under review, which is a collection of papers given at a symposium on planetary atmospheres held at the University of Chicago, in September 1947, in connexion with the fiftieth anniversary of the Yerkes Observatory. The inspiration for the symposium came from Prof. G. P. Kuiper, who has been responsible for some of the most important developments of the subject, and who has also edited this book. I have myself no great liking for symposia, but if they all were to succeed in producing such a wealth of exciting and significant contributions as this one, I would willingly change my opinion. Much of the work recorded here is of outstanding quality, and the greater part of it is American in origin; one of the pleasing virtues of a good book is that the authors take little notice of the first of these facts and none at all of the second. R. O. REDMAN

CONGRESS OF THE EUROPEAN BREWERY CONVENTION

European Brewery Conference

Congress, Lucerne 1949. Vol. 1. Pp. ix+273. (New York and Amsterdam: Elsevier Publishing Co., Inc.; London: Cleaver-Hume Press, Ltd., 1949.) 37*s*. 6*d*.

THE European Brewery Convention was set up in 1947 with the object of "co-ordinating the scientific work done in different countries in the technical fields of Brewing and Malting". This volume contains three symposia—the papers submitted at the second biennial congress of the Convention.

In the first of these symposia, proteins in brewing, E. Sandegren (Sweden) reports recent advances in the work of fractionating barley proteins which has been proceeding in Uppsala and Stockholm in recent years. Salting-out with phosphates was followed by the application of the polarographic method to the

fractions and their modifications similarly separated from malt and wort. Ultra-centrifuging and electrophoresis, which had previously been employed with success to barley and malt fractions, are more complicated when applied to worts and beers. The amperometric titration was applied to the determination of sulphydryl groups in the proteins. Protein haze in beer, which is increased by oxidation, is in part associated with the β-globulin of barley, which contains reactive sulphur. The possibility of distinguishing malt from hop tannin by means of ultra-violet spectrophotometry is indicated. B. D. Hartong, J. H. St. Johnston and others report their work on protein and protein-tannin precipitates which occur during brewing operations and in beer storage. Communications by E. C. Barton-Wright and the Wallerstein Laboratory (New York) workers, on yeast nutrition and factors controlling fermentation, are perhaps the remaining outstanding papers. But there are many more, and most of the work reported was previously unpublished. An admirable review of proteins in brewing is furnished by H. Lundin, in which he discusses the formation of adaptive enzymes and A. I. Virtanen's opinion that much cell protein functions as enzymes or apoenzymes.

The part of the volume devoted to barley research includes eight communications from European countries covering breeding and agricultural aspects. The symposium on production of sterile beer by means other than pasteurization includes five papers involving work on irradiation methods, aerosols for cleaning air, etc.

Most of the papers are in English, a few in French, and all summaries are in English, French and German. There is no general index; but references appear at the end of each communication. This book is indispensable to the research and scientific worker in any of the fields covered.

R. H. Hopkins

FAIRY WRENS OF AUSTRALIA

The Fairy Wrens of Australia

Blue Birds of Happiness. By Neville W. Cayley. Pp. viii+88 (23 plates). (Sydney and London: Angus and Robertson, Ltd., 1949.) 15*s*.

THIS is a popular account of a group of birds known in Australia as fairy wrens. They have, however, no connexion with the true wrens, but are closely related to the warblers and are placed in the Malurinæ, a sub-family of the Muscicapidæ, which includes the Turdidæ and Sylviidæ, etc. Except for one species in New Guinea, the sub-family is confined to Australia.

The females are all rather dull-coloured, brown above and white below, but the males are a striking combination of colours; some are a beautiful mixture of blue and purple with a little brown and white; one species is black and white, while in another the blue of the back is replaced by red; and in a species confined to northern Australia the coloration resembles the female, except for the blue tail and purple crown. The author recognizes twelve species which in the present work he places in six genera, although in a previous volume he only admitted two genera, *Malurus* and *Rosina*, this last genus being for the purple-crowned fairy wren, *R. coronata*, of Northern Australia. Judging by the coloured plates, I consider the first arrangement is right, if indeed all the species should not be in *Malurus*.

Mr. N. W. Cayley has devoted much time to field study of the changes in plumage of these birds and has come to the conclusion that the male moults direct from the juvenile plumage into that of the adult. After the breeding season, a non-breeding dress is assumed; but, when the birds are about three years old, the assumption of the non-breeding dress is omitted, and the males moult straight into the usual full plumage. According to the author, moreover, the colour of the plumage increases in brightness as the bird grows older. These observations do not appear to have been made with marked birds, and, according to Lack, the average life of a robin is one and a half years, so that it is unlikely that a fairy wren lives much longer.

Details are given of the discovery of each species, and it is interesting to note that, out of the twelve species here recognized, seven were first described, and in some cases also discovered, by John Gould. Some of the fairy wrens are widely distributed, but their range is not continuous and a number of local races have been described. The best-known member of the genus is *Malurus cyaneus*, which is common in gardens and shrubberies even in the middle of cities and is everyone's favourite. The display of the male is described, and, what with the positions it assumes and the bird's bright coloration, it must be very striking. Throughout the genus the same type of nest is constructed, a dome-shaped structure with an entrance at one side protected by a hood. Usually the nest is placed on or near the ground, but where cats abound the birds have learnt to build their nests out of reach.

Though not related, the emu wrens (*Sipiturus*) are included in the book. They are some of the smallest birds found in Australia, brown in colour with heavy streaks on the mantle, and in the males the throat is blue. But the most striking feature of the bird is its tail, which is composed of six feathers (an unusual number), the two middle ones being the longest. Each feather is decomposed and spiny. The early settlers saw in these feathers a resemblance to the feathers of the emu, hence the name emu wren. The genus contains but three species, one inhabiting the Mallee country of Victoria and South Australia, and the other two being widely but very locally distributed in the dry and swampy heath lands of the coastal belt of eastern and western Australia. They are shy birds and seldom take wing, creeping and hopping through the undergrowth in pairs or small parties.

There are nine coloured plates, each figuring the male and female of two different species. In addition to the birds, there are pleasing drawings of typical bright-coloured flowers found in the birds' haunts, and, after the fashion of John Gould, the author gives the names of the flowers, which adds much to the interest of the book. The drawing of the birds is good and the colours appear to be fairly accurate; but the reproduction of the plates is not so pleasing. There are twenty excellent photographs of birds, nests and types of country in which they are found. It is sad to relate that since the book was published the author has died. Neville Cayley has probably done more than anyone to popularize the study of birds in Australia, and his "What Bird is That?" is one of the best field books published.

N. B. Kinnear

Molecules in Motion

By Prof. T. G. Cowling. (Hutchinson's University Library, No. 44.) Pp. 183. (London: Hutchinson's University Library, 1950.) 7*s*. 6*d*. net.

THIS is a mathematical treatment shorn of all difficult mathematics, in which the associated experimental physics is largely taken for granted and so mentioned very briefly, leaving a skeleton which makes a reasonably connected essay. The opening chapters explain in an elementary way the historical development of the kinetic theory, and the general properties common to all gases. Mean free path phenomena of diffusion, thermal conductivity, and viscosity are discussed clearly, and the later chapters on the application of statistics, Maxwell's distribution, and the atmosphere contain some very useful ideas. The last chapter on electricity in gases is far too brief for such a topic, but leads up to an account of a degenerate electron-gas and so can be considered relevant.

In the section on viscosity, the accommodation coefficient and Sutherland's formula are considered. The reader to whom this is directed is no dilettante. Surely he deserves a more carefully considered definition than: "Viscosity is the stiffness which makes it difficult to pour or stir treacle"—which might apply to writer's cramp, but for the illuminati n of the next sentence, "It is most apparent in treacly liquids . . .". A number of experimental statements might have been made more explicit.

As a purely academic essay, the book must be judged successful within the limits that the author has set himself; as a popular account, one feels that it would appeal more strongly to the interested layman if it had been more rigorously worded; while the reader already possessing a substantial background of experimental physics may find it a helpful introduction to the more comprehensive treatises on the kinetic theory. G. R. NOAKES

Ultrasonics

By Benson Carlin. Pp. xi+270. (New York and London: McGraw-Hill Book Co., Inc., 1949.) 30*s*.

THERE are now a number of books dealing with ultrasonic applications in general, but the present one is more restricted. The author, when at the United States firm of Sperry Products, was occupied in flaw-detection, and this is the main concern of the book, though there is also a chapter on ultrasonic agitation. On these themes hangs rather infelicitously an account of ultrasonic waves and some of their general properties, in which the author's attitude to the reader seems to be the unhistoric one; for the author presupposes a knowledge of radar, which is used as an analogy for discussing ultrasonic testing. The emphasis is, in fact, on circuits rather than on physical principles, which seem to follow rather than precede the circuits on which they are based. Thus, we have to wait for sixteen pages before we are told what frequency and wave-length are. Diffraction, so important in flaw detection, is dismissed in six lines, while resolving-power is not mentioned.

Although the text will disappoint a physicist, an electronic engineer—especially one versed in radar technology—will revel in the display of circuits, and the able discussion of their relative merits. There is also much practical information about piezo-electric and magnetostrictive sources, their mounting, testing and relative suitability to the applications under discussion, which is not readily to be found, certainly not grouped in handy form, elsewhere. This and the final chapter on the author's experience in the ultrasonic testing of materials are the most valuable portions of the text.

The reader in Great Britain accustomed to staid scientific treatises must not be surprised, in view of the country of origin of this book, to find a rather breezy phraseology, although, even so, I was rather perturbed to read (on p. 255) in a final summing-up of ultrasonic testing: "Most of the bugs inherent in it have been ironed out". E. G. RICHARDSON

On the Systems formed by Points regularly distributed on a Plane or in Space

By A. Bravais. Translated by Amos J. Shaler. (Crystallographic Society of America, Memoir No. 1.) Pp. viii+113. (Irvington-on-Hudson, N.Y.: Crystallographic Society of America, c/o Phillips Laboratories, Inc., 1949.) 3.90 dollars.

IT is appropriate that the hundredth anniversary of the presentation of Bravais's historic memoir on crystal lattices should be celebrated by the first English translation. Although this work is an essential part of the foundation of the science of crystallography, it is probably true to say that scarcely any of those working in this field to-day have read this memoir. Here is the complete and fundamental derivation of the five two- and the fourteen three-dimensional crystal (Bravais) lattices, and also of the corresponding reciprocal lattices.

The translator is to be congratulated on making this historic memoir so widely available to present-day crystallographers. The reading of books such as this will help the realization of the debt which we owe to those who worked on the theoretical and practical problems of crystals in the days before the discovery of X-ray diffraction. N. F. M. H.

Forage Crops

By Prof. Gilbert H. Ahlgren. (McGraw-Hill Publications in the Agricultural Sciences.) Pp. x+418. (New York and London: McGraw-Hill Book Co., Inc., 1949.) 42*s*. 6*d*.

THE author, who is professor of farm crops in Rutgers University, New Jersey, has designed this book as a companion volume to H. K. Wilson's "Grain Crops", recently published in the same series; hence he restricts his attention to such crops as are "harvested by man and later fed to livestock". In forty-one short chapters he attempts to embody "the facts and fundamentals associated with the production of hay and silage crops".

Following three introductory chapters, twenty-one chapters are devoted to individual treatment of the more important legumes and grasses in order to introduce the student to the characteristics and adaptations associated with each. The author describes this as "detailed species study", but the treatment is far too elementary and superficial to give the student much idea of the plants. The remainder of the book is devoted to topics "common to all the forage crops", for example, hay mixtures, soil and cultural treatments, seedbeds, hay and silage, plant improvement, diseases and pests, etc.; again the treatment is scarcely adequate.

In his preface the author states that he "has drawn freely from hundreds of scientific and popular bulletins covering this important field" and expresses his hopes that the book will not only meet "an important need for a modern textbook in forage crops" but "also prove valuable as a reference book for workers in the field of agronomy". It is very

noticeable, however, that the author has confined his attention entirely to North American crops and conditions. Further, of the 522 references cited, only one derives from outside North America, and the same is true of the 393 tables in the book. The volume brings together much information which will be useful for elementary students of crop husbandry in North American agricultural colleges, but it is too parochial in outlook to interest more than a very few people in Great Britain. W. B. BRIERLEY

Dictionary of Genetics

Including Terms used in Cytology, Animal Breeding and Evolution. Compiled by Dr. R. L. Knight. (Lotsya, a Biological Miscellany, Vol. 2.) Pp. xii+183. (Waltham, Mass.: Chronica Botanica Co.; London: Wm. Dawson and Sons, Ltd., 1948.) 4.50 dollars.

THIS book contains, or attempts to contain, every word connected with genetics in the widest sense. It therefore spreads over (though it does not cover) the whole range of biology; psychology and anatomy, embryology and biochemistry are all represented. It includes three thousand terms as compared with the five hundred in Darlington and Mather's recent glossary of the subject. Definitions are attempted; but there does not seem to be any standard or consistency in the use of alternative or related terms. Nor are there references or dates of origin; yet it is known, and it is worth relating, who invented such terms as gene and genotype. For some terms (such as cytomicrosome), the author proceeds by describing *ignotum per ignotius*; others (such as mitoschisis or merostathmokinesis) have never been used except by their anonymous inventors. Let us hope that others again (such as thermocleistogamy, tachyauxesis and spermiocalyptrotheca) never will be used. Others which have a known meaning lose it (such as "mass mutation" in *Œnothera*) or do not appear at all (such as "sterility"). Then again, others (such as heterofertilization or parthenogamy) describe rare or even imaginary phenomena. One supreme example which is non-existent as a technical term (perultimate chromomere) appears to be at once misplaced, misspelt and misdefined.

The majority of these terms, if they really existed, would be a reproach to biology; but I am happy to acknowledge that they are unknown to me. A dictionary of scientific terms may be a museum, or it may be a workshop. This book, however, is better described as a junk shop; and it may be that someone interested in words—even though not a student of the science of "thremmatology" or the theory of the "Genorheithrum"—will turn over its glittering and unauthentic fragments with the fascination of the collector looking for a gem brighter and more improbable than all the rest.

C. D. DARLINGTON

Twelve Lectures on Theoretical Rheology

By Prof. Markus Reiner. Pp. 163. (Amsterdam: North-Holland Publishing Co.; New York: Interscience Publishers, Inc., 1949.) 9 f.

ALTHOUGH rheology is a branch of physics, many of those concerned with its practice were trained in chemistry or in other sciences, and are unfamiliar with the tensor theory and notation which so greatly simplifies the treatment of its fundamental principles. Prof. Markus Reiner's earlier "Ten Lectures" will be remembered by many as their first introduction to the use of tensors in rheology. Unfortunately, the number of copies of the earlier edition which reached Great Britain was limited; moreover, the printing, undertaken by those who were clearly unfamiliar with Latin script, left much to be desired. The enlarged new edition, "Twelve Lectures", remedies these defects, being excellently produced. There are also certain improvements and simplifications in the tensor treatment, as well as a number of useful additions.

As a companion volume to Prof. Reiner's "Deformation and Flow", this book is to be highly recommended. The author is a born teacher and has a quite unusual capacity for foreseeing where the reader's main difficulties are likely to arise. Thus, although much of the subject-matter is to be found in older and larger text-books, rheologists, especially those who have lost their youthful capacity for digesting the works of Love or Lamb, will welcome this far simpler presentation.

The author points out that "the treatment is phenomenological and does not take account of the discrete 'atomistic' structure of matter and its dynamical (kinetic) theory". This is a welcome reaction to the prevalent tendency to regard the 'atomistic' approach as the only legitimate line in physics. G. W. S. B.

New Developments in Ferromagnetic Materials

With Introductory Chapters on the Statics and the Dynamics of Ferromagnetism. By J. L. Snoek. Second revised and enlarged edition. Pp. viii+139. (Amsterdam and New York: Elsevier Publishing Co., Inc.; London: Cleaver-Hume Press, Ltd., 1949.) 15*s*.

IT is only fair to state that, while one is glad to welcome a second edition of Dr. J. L. Snoek's most valuable little book, it contains practically no new material. In fact, the additions or enlargements consist only of three pages of notes, mainly on ferromagnetic absorption and dispersion at high frequencies, added to the original appendixes. This is a pity, for one cannot imagine, for example, that the Dutch have lost all interest in ferrites; and all of us interested in the theory and experiment of magnetization processes would have liked to learn more of their recent work, particularly in view of the note in italics on p. 67 of each edition. L. F. B.

The Works of George Berkeley, Bishop of Cloyne

Edited by A. A. Luce and T. E. Jessop. (Bibliotheca Britannica Philosophica.) Vol. 3: Alciphron or The Minute Philosopher. Edited by T. E. Jessop. Pp. v+338. (London and Edinburgh: Thomas Nelson and Sons, Ltd., 1950.) 30*s*. net.

THIS volume of the new edition of Berkeley contains one work only, the longest of his books and the most perfect in literary form. It is one of the liveliest and finest philosophical dialogues in English, or perhaps in any language; but it contains practically nothing of Berkeley's own philosophy. As stated on the title page, it is "An apology for the Christian religion against those who are called Freethinkers". Berkeley is attacking, not so much the theories of writers of learned books, as the fashionable paganism of the 'bright young people' of the 1720's, who resembled those of the 1920's in eagerly picking up philosophical or quasi-philosophical arguments out of the learned books in order to justify their vices and frivolities. "Alciphron" was the most popular of Berkeley's books in his own day and bears the passage of time better than such controversial works usually do. A. D. R.

LIFE AND WORK OF OLIVER HEAVISIDE
(MAY 18, 1850–FEBRUARY 3, 1925)

"FROM time to time there live among us men of genius whose creative work is inadequately recognised by their contemporaries but who, later, are found to have rendered a service of the highest value to the advancement of Science—such a man was Oliver Heaviside."*

During the afternoon and evening of May 18, a commemorative meeting in honour of Oliver Heaviside was held at the Institution of Electrical Engineers under the chairmanship of the president of the Institution, Prof. E. B. Moullin, supported by the president of the Royal Society, Sir Robert Robinson. This was followed, on May 20, at the Sorbonne in Paris, by a similar meeting organised by the Société des Radioélectriciens and conducted under the chairmanship of Prince Louis de Broglie, permanent secretary of the Paris Academy of Sciences.

The afternoon session of the London meeting was devoted to the presentation of an appreciation of "Heaviside, the Man" by Sir George Lee, formerly engineer-in-chief of the Post Office, and to supporting tributes by Sir Robert Robinson, Sir Edward Appleton, Dr. M. J. H. Ponte (president of the Société Française des Électriciens), Sir Archibald Gill, Dr. O. E. Buckley (president of the Bell Telephone Laboratories of America), Prof. Harold Jeffreys, Sir Edmund Whittaker and Dr. G. F. C. Searle, who, from varied points of view, testified to the wide mathematical, physical and engineering significance of Heaviside's work. The presence and contribution of Dr. Searle, now eighty-five years of age, were much appreciated by all present because of his close and extended friendship with Heaviside. They met first in 1892; one of the few real friendships of Heaviside's secluded life resulted, and Dr. and Mrs. Searle did much to assist him during the difficult domestic circumstances which existed during the last ten years of his life.

The evening session was devoted to the presentation of abstracts of four papers (available in advance) dealing with various aspects of Heaviside's work. One, by Prof. B. van der Pol, was concerned with the operational calculus devised by Heaviside for the solution of the problems of telegraph and telephone line transmission which were his main preoccupation. Another, by Prof. Willis Jackson, dealt with his contribution to electromagnetic theory, notably with his reformulation of Maxwell's equations and his establishment of the theory of line transmission on Maxwell's basis. A third, by Dr. W. G. Radley, discussed the impact of Heaviside's work on the subsequent development of telecommunications; while a fourth, by Mr. H. J. Josephs, consisted of a reconstruction of some of Heaviside's very extensive unpublished notes.

The meeting was made the more interesting by an exhibition which included a pictorial survey of various stages of Heaviside's life, the diploma of doctorate *honoris causa* presented to him by the University of Göttingen, a selection from his unpublished manuscripts and a number of letters, including one from Lord Rayleigh, who, writing as secretary of the Royal Society to inform Heaviside of the acceptance of one of his papers, remarked, "Both our referees, while reporting favourably on what they could understand, complain of the exceeding stiffness of your paper. One says it is the most difficult he has ever tried to read. Do you think you can do anything by illustrations or further explanations to meet this? As it is I should fear that no-one will take advantage of your work."

The programme of the Paris meeting comprised an opening address by Prince Louis de Broglie, followed by contributions from M. Ed. Picault, inspector-general of the French Post Office, Prof. P. Humbert, of the University of Montpellier, M. S. Colombo, senior scientist of the Centre National de la Recherche Scientifique, M. P. M. Prache, president of the Telecommunications Section of the Société Française des Électriciens, M. L. Bouthillon, of the École Polytechnique, Sir Edward Appleton, representing the Royal Society, and Prof. Willis Jackson, representing the Institution of Electrical Engineers.

There were also on exhibition a series of letters between Heaviside and M. J. F. T. Bethenod, the eminent French industrial inventor and scientist, who in a letter dated December 7, 1917, paid the following tribute to Heaviside: "The dream of my life has been to sign my name to works like yours because, à tout ou à raison, I imagined myself to be capable of it when I was 20 years old. Fate has decided otherwise, for fifteen years I have had to devote myself to the study of industrial questions and I fear that after the war there will be no more time."

Oliver Heaviside was born and lived, to the age of eighteen, at 55 King Street (now Plender Street), London, W.1. His father was a wood engraver, and his uncle, on his mother's side, the famous inventor and telegraph pioneer, Sir Charles Wheatstone. The latter was no doubt responsible for his initial employment at Fredericia in Denmark in 1868 as telegraph operator with the Danish–Norwegian–English Telegraph Co., one of the first telegraphic organisations to use Sir Charles's apparatus. The first Anglo–Danish cable was laid between Newcastle upon Tyne and Fredericia in 1868, and when, in 1870, this cable was taken over by the Great Northern Telegraph Co., Heaviside was transferred to Newcastle as chief operator. His notebooks, now in the possession of the Institution of Electrical Engineers, give details of his early experimental work and of the problems which soon began to exercise his mind. On July 5, 1872, he published his first paper entitled "Comparing Electromotive Forces" in the *English Mechanic*, and thus began the spate of publications which, brought together in the two volumes of his "Electrical Papers" and the three volumes of his "Electromagnetic Theory", cover more than 2,500 pages of close type and contain about 1¼ million words or their mathematical equivalent. His early papers were of an essentially practical character. His notes show, however, that he was seeking mathematical means of clarifying the phenomena he observed, and that he soon became aware that their explanation would require a more comprehensive theory of line transmission than was afforded by the submarine cable

* Foreword, *J. Inst. Elect. Eng.*, April 1950.

solution formulated by Kelvin in 1855, which took account only of line resistance and capacitance and ignored—though quite justifiably for the signalling conditions with which Kelvin was then concerned—self-inductance.

By 1874 he had decided that his employment with the Great Northern Telegraph Co. was interfering too seriously with his theoretical work, and towards the end of that year he resigned and returned to live with his parents in London. The family moved to Paignton in 1889; then, following the death of his parents, Oliver lived in Newton Abbot from 1897 until 1909, when he was offered a home by Miss Way, sister-in-law to his brother Charles, and lived at Homefield, Torquay, until his death in 1925. From 1874 onwards he worked in seclusion, and during the later years of his life under conditions of considerable austerity.

Oliver Heaviside's first major analytical contribution, made in 1876, consisted of his extension of Kelvin's solution to include the effect of self-inductance and of his recognition of the fact that signals were transmitted along the line with a velocity determined dominantly by the product of the capacitance and inductance per unit length, and which, contrary to the existing belief, was independent of the line length. It was not until 1881, however, that he linked these phenomena with Maxwell's theory of electromagnetic wave propagation. Between 1881 and 1885 he devoted himself to a discussion of this theory, and of vector algebra, and to a representation of Maxwell's equations in the vector algebra form in terms of the electric and magnetic field intensities in which they are now normally stated. He did not claim to have added anything to Maxwell's theory as such, and in respect of vector analysis gave full credit to the priority of Willard Gibbs; but his achievement in putting this theory into a form more suitable for use in the solution of practical problems was considerable, as was recognized by Hertz, who came to a similar formulation of it a few years later. In the course of his analysis, Heaviside independently derived Poynting's flux of energy theorem within a few months of Poynting himself, and in more general form, but in all subsequent references spoke of it as the Poynting flux.

Having satisfied himself that his line equations formulated in 1876 conformed, subject to certain limitations, with Maxwell, he proceeded to develop a comprehensive theory of line propagation, on which all the subsequent developments in telephone line communication have been based.

To Heaviside's great disappointment, his advocacy of the beneficial effect of artificially increasing the line inductance and his proposals for doing so were not acceptable to Sir William Preece, then engineer-in-chief of the British Post Office. They had no practical outcome until, in a paper read to the American Institute of Electrical Engineers in 1899, Prof. M. I. Pupin, of Columbia University, described experiments which showed convincingly that a line of high uniformly distributed inductance could be substantially imitated by one of lower self-inductance in which coils were located at appropriate regular intervals along its length—one of the alternative suggestions of Heaviside himself.

In 1901 the British Post Office began experiments on 'loading coils', as they were called later, and in the following year a complete circuit in the first London–Birmingham telephone cable was loaded experimentally. The first British long-distance circuits to be loaded for practical purposes were in the Liverpool–Warrington cable in 1903, and the procedure became a standard practice in main underground cables immediately after the First World War.

Heaviside had no better fortune with the mathematicians than with the engineers. The operational calculus which he developed for dealing with the propagation of disturbances along lines evoked very severe criticism, a consequence of the unsystematic way in which he treated these problems and of his lack of concern for rigour in the mathematical sense. He wrote: "Those who may prefer a more formal and logically-arranged treatment may seek it elsewhere and find it if they can; or else go and do it themselves"; and "I do not write for rigourists (although their attention would be delightful) but for a wider circle of readers who have fewer prejudices, although their mathematical knowledge may be to that of the rigourists as a straw to a haystack". This type of statement—and many more potent ones might be quoted—did not, of course, contribute to the removal of misunderstanding; but suffice it now to say that his methods were later proved to be fully justified, and that Sir Edmund Whittaker was able to write in 1929: "Looking back on the controversy after thirty years, we should now place the Operational Calculus with Poincaré's discovery of Automorphic Functions and Ricci's discovery of the Tensor Calculus as the three most important mathematical advances of the last quarter of the nineteenth century. Applications, extensions and justifications of it constitute a considerable part of the mathematical activity of to-day."

During the period 1889–1902, Heaviside wrote a number of papers dealing with the electromagnetic effects associated with electrically charged bodies in steady and accelerated motion. In particular, in 1889, he stated, within half a page, the relation normally attributed to Lorentz, who derived it three years later, for the force experienced by a charge in steady motion in a magnetic field. J. J. Thomson had previously given the force as one-half the correct value, and it would seem that Heaviside sensed the correct relation intuitively from Thomson's analysis, but did not trouble to record that he had done so.

In 1902 he contributed an article on "The Theory of Electric Telegraphy" to the tenth edition of the "Encyclopædia Britannica". In the course of this article he stated that Hertzian waves travelling round the earth might "accommodate themselves to the surface of the sea in the same way as waves follow wires", and that there might "possibly be a sufficiently conducting layer in the upper air. Then the guidance will be by the sea on the one side and the upper layer on the other." It was fitting that the first experimental demonstration of the truth of this remarkable and far-reaching prediction came through the work of another famous Englishman, Sir Edward Appleton, and that Heaviside's name, joined with that of Kennelly, should be associated with the layer.

It is also of interest to note the extent to which Heaviside's mind was prepared for the recent developments in microwave technique as revealed by his emphasis on the care to be exercised in using his transmission-line theory at frequencies for which the wave-length is of the same order as the conductor separation, and by a limited treatment in 1888 of wave propagation inside a cylindrical conducting tube—what is now called a cylindrical wave-guide—

some nine years before Rayleigh's more comprehensive analysis.

It remains to mention his advocacy, dating back to 1882, of the rationalization of units, a topic which is receiving much attention at the present time in connexion with discussions of the M.K.S. system, and also his contributions to the terminology of electrical engineering. The number of terms which originated with him is remarkable. Thus, he was responsible for the introduction of the words resistance, conductance, inductance, permittivity, impedance, admittance, reluctance, permeance, distortion and electrets; while several other terms which did not originate with him owe much to him for their now general application.

The first volume of Heaviside's great work, "Electro-Magnetic Theory", was published in 1893 and the second in 1899. In the preface of the first edition of the third volume, Heaviside stated that it had been his intention to publish the third volume in 1904 and a fourth in 1910. But circumstances had not been favourable; his third volume did not appear until 1912, while the fourth and concluding volume was never published.

The portion of the unpublished notes discussed by Mr. Josephs was presumably to form part of this fourth volume. Whether the manuscript was ever completed is not known, though Heaviside was engaged in negotiations for its publication at intervals during the period 1917–22. It is a great misfortune that many of these notes, now in the possession of the Institution of Electrical Engineers, are in very bad condition, but Mr. Josephs has nevertheless been able to piece together substantial portions of the proposed volume. The notes contain some remarkable mathematical work; they show Heaviside to have been much exercised to the end with ideas on the electrical theory of matter and with the statistical nature of physical laws, and record his continued striving towards the development of a unified theory of the electromagnetic and gravitational fields, a topic on which he made his first publication in 1893.

Heaviside's life was in some respects a great tragedy, but he emerges from it a man of tremendous intellectual stature; an extreme individualist, who in one of his letters says: "My results, however imperfect they may be, have at least the recommendation of having been worked out in a mind uncontaminated by the prejudices engendered by prior knowledge acquired at second-hand"—a man who scorned honour when it was offered in his lifetime, but to whom it may now be given in the abundance he deserves.

He was elected a fellow of the Royal Society in 1891; a Civil List pension was awarded to him in 1896; in 1905 the University of Göttingen conferred on him the degree of Ph.D.; he was elected an honorary member of the Institution of Electrical Engineers in 1908 and of the American Institute of Electrical Engineers in 1918, and when in 1921 the Institution of Electrical Engineers founded the Faraday Medal in memory and honour of that great scientific worker, they selected Heaviside as the first recipient. The task of presenting the Medal to Heaviside fell to J. S. Highfield, then president, who wrote: "It is impossible to give any adequate account of one who so despised what most men desire; but when I left him I felt that he was content, that he respected the Institution, and that it had pleased and made happy one of its famous men".

WILLIS JACKSON

NEW CYTOTOXIC AGENTS WITH TUMOUR-INHIBITORY ACTIVITY

By DR. F. L. ROSE, O.B.E., and DR. J. A. HENDRY
Imperial Chemical Industries, Ltd., Research Laboratories, Hexagon House, Manchester, 9

and DR. A. L. WALPOLE
Imperial Chemical Industries, Ltd., Biological Laboratories, Wilmslow

THE observations of our colleagues Templeman and Sexton[1] upon the effect of carbamic esters on the growth and morphology of cereal seedlings, those of Haddow and Sexton[2] upon the influence of selected members on animal tumours, and the findings of Haddow, Paterson and co-workers[3] that the ethyl ester (urethane) has a therapeutic action on certain forms of leukæmia in man, prompted us to attempt to elucidate the chemical basis of the several effects produced by these compounds. To this end we prepared some thirty simple homologues of urethane and examined them for growth-inhibitory activity against the Walker carcinoma 256 in rats. Of these, only *bis*- and *tris*-carbethoxyamine even approached urethane in activity, a finding which has been amply substantiated in similar investigations by Haddow (private communication) and by the more recent work of Skipper and his associates[4,5], who have studied the toxicology and the action upon experimental leukæmia of a similar series of carbamates.

At that time we envisaged the possibility that urethane interferes with cellular proliferation by virtue of its capacity to react with amino-groups; the fact that potassium cyanate had been claimed to have anti-mitotic action lent support to this idea. In consequence, we examined a wide range of substances capable of analogous interaction with these groups to yield not only ureas, as does urethane, but also other functional derivatives. Most of these were monofunctional in that each molecule carried only one reactive group such as halogeno, cyano, thiocyano, cyanate, *iso*cyanate, keto, aldehydo, thiol or alkylthiol. A minority were bi- or tri-functional, this being achieved, for example, by including an alkylene chain between two reactive groups as in compounds of the type $EtO.CO.NH(CH_2)_nNH.CO.OEt$, so that the nature and disposition of the reactive groups was not unlike that in the 'nitrogen mustards'. Altogether, rather more than a hundred such derivatives were prepared and examined before significant growth-restraining activity on the Walker tumour was encountered, and the purpose of this communication is to record those initial observations, together with later developments which may have a fundamental bearing on the chemistry of cell division.

The active substances fall into three classes. In the chronological order of the discovery of their effect these are: (*a*) polymethylolamides, (*b*) *bis*-epoxides, (*c*) structures carrying two or three ethylene imine residues*. We were led in the first place to examine substances of type (*a*) because of their known application in paper and textile technology where, as described by our colleague Mr. J. G. Evans[6], their usefulness is probably associated with poly-alkylating function, a feature that is clearly of significance in the 'sulphur' and 'nitrogen mustards', and because

* Since this paper was prepared, workers at and associated with the Sloan-Kettering Research Institute, New York, have described the use of ethylene imine derivatives against certain experimental cancers (*Arch. Biochem.*, **26**, (2), 319, 321 (1950)).

the importance of this property had been brought to our notice by the work of Prof. A. Haddow and his group (private communication and ref. 7) in the particular case of the aryl derivatives of the latter. While compounds of type (*a*) were under investigation, Haddow also told us of the hypothesis (since further developed and published[8,9]) that the specific cytotoxic action of the nitrogen mustards might be due to the formation of linkages between cell nuclear components. This concept further encouraged us to examine the epoxides and ethylene imines—compounds which we knew to have similar textile uses to those of the methylolamides.

It is convenient here to give a brief account of the salient biological properties of the three types, selecting from the one hundred and fifty preparations so far examined those which produce the most striking effects.

Methylolamides

Tumour-inhibitory activity in this class has been confined exclusively to derivatives of 1 : 3 : 5-triazine, the most effective substance encountered being the condensation product of melamine with three molecular proportions of formaldehyde, which in the monomeric state is formulated as (I). This substance is only slightly soluble in organic solvents and in water, and is administered as a fine aqueous suspension.

In a typical experiment on the inhibition of tumour growth, (I) was given intraperitoneally to rats bearing implants of the Walker tumour. Dosage began on the day following implantation of the tumour, and a total of 225 mgm. per 100 gm. rat was given in single doses of 25 or 50 mgm. per 100 gm. during eleven days. Fifteen days after implantation, the control animals, which had been left untreated, were sacrificed and the tumours weighed. At this time the weights of the tumours in the treated group were estimated by palpation; seven days later these animals were killed and the tumours dissected out and weighed. The results are shown in Table 1.

TABLE 1. EFFECT OF TRIMETHYLOL MELAMINE (I) ON THE GROWTH OF THE WALKER RAT CARCINOMA 256 (INDIVIDUAL TUMOUR-WEIGHTS IN GM.)

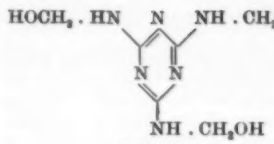
Control series (untreated) at 15 days	Treated series (total dose of 225 mgm./100 gm. rat)	
	At 15 days	at 22 days
41, 41, 32, 31, 30·5, 22·5, 19, 18, 13, 9	1·5, 0·75, 0·5, 0·2, 0·1, 0, 0, 0, 0, 0	10, 14, 10, 5, 2, 0, 0, 0, 0, 0*

* Dead on day 19, no tumour found.

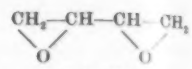
The mean gross weight of the control animals increased during the first fifteen days of experiment from 95·9 to 142·4 gm., and that of the animals in the treated group from 96·0 to 122 gm. It has been shown in subsequent work that the compound has an inhibitory effect upon gain in body-weight in tumour-free animals.

Essentially similar results have been obtained repeatedly, but it is to be noted that if dosage is delayed until the tumour has been growing several days, inhibition of its growth is less marked, and under these conditions no actual regressions have been observed.

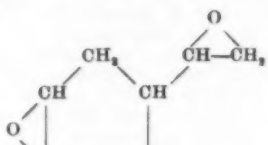
After single doses to rats bearing Walker tumours of several days growth, mitotic abnormalities develop in great numbers in the tumour cells. They include the formation of chromosome bridges and fragments



I (*M*.7924)

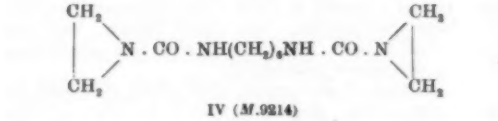


II (*M*.8838)

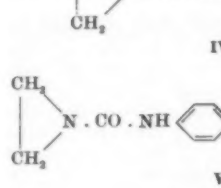


III. (*M*.8840)

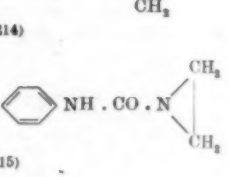
IV (*M*.9214)



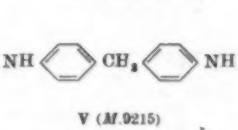
V (*M*.9215)



VI (*M*.9500)



VII (*M*.9604)



VIII (*M*.9607)

at anaphase in some cells (Koller's "specific chromosome effect"), while others are seen to be swollen with chromosomes or chromosome fragments densely contracted and scattered without orientation in the cytoplasm. Accompanying these changes is a significant retardation of tumour-growth.

The compound exhibits some activity also against transmissible lymphoid leukæmia in *Afb* mice, and against grafts, in Strong *A* mice, of a spontaneous mammary adenocarcinoma from a mouse of that strain. A dog with symmetrical enlargement of the lymph nodes diagnosed as malignant lymphoma ('leukæmia') was given seven intravenous doses of 50 mgm. per kgm. of the agent in aqueous suspension,

on successive days. The glands rapidly returned to their normal size and the general malaise of the animal disappeared. It remained in apparent health for four months and was then lost sight of.

In normal animals, the toxic action of the compound is mainly directed against proliferating tissues such as the hæmatopoietic and lymphatic systems, the intestinal epithelium, and the germinal epithelium of the testis; although other changes are seen which appear to be due to a local toxic action upon epithelial and endothelial cells in various sites. The appearance of the bone marrows from dogs treated with lethal doses indicates a severe toxic process affecting the early stages of myelo- and erythro-poiesis. The possibility that a similar process affects bone marrow cells in the resting stage cannot be excluded. This action is reflected in the peripheral blood in a dramatic fall in the leucocyte count, mainly affecting the polymorphs, and a less-pronounced but definite downward trend in the erythrocyte count. These changes do not develop fully until several days after the agent is given, and with suitable adjustment of dosage recovery may occur. In the rat the peripheral blood changes suggest that the erythropoietic system is relatively more sensitive to its action. Characteristic of the response in this species is a sudden onset of anæmia sufficiently severe to account for death several days after the administration of the drug.

The effect upon lymphatic tissue varies in nature and intensity according to species and site. In the dog there is a central atrophy in the lymph nodes and widespread pyknosis of lymphocytes. In the mouse, mitotic abnormalities are seen in the thymus and lymph nodes, where the most common change is pyknosis and fragmentation of chromosomes. Effects of similar nature but less marked are seen in the cells of the Lieberkühn crypts in this species. Changes in the testis of the rat and the dog include loss of germinal cells and the appearance in the tubules of large multinucleate cells. The latter appear to arise from spermatocytes by repeated nuclear division without division of the cytoplasm. Other effects of the substance upon epithelial and endothelial cells are manifested in patches of hæmorrhage and interstitial inflammation in the lungs (dog), and minor pathological changes in the kidney and liver (rats).

bis-Epoxides

Of the various compounds of this class examined, the most outstanding are butadiene dioxide (mixed isomers, II) and vinyl *cyclo*hexene dioxide (III), which were among the first few representatives of the class selected for test against the Walker tumour. Both these are apparently bland colourless oils with high lipoid solubility. The results of experiments in which these compounds were tested against the tumour are shown in Table 2. In each case the total dose, given over the first ten to twelve days of experiment, is recorded together with the corresponding percentage inhibition of tumour growth at fourteen days, calculated by the formula:

$$\text{Percentage inhibition} = 100\left(\frac{\text{control tumour weights} - \text{treated tumour weights}}{\text{control tumour weights}}\right)$$

Postmortem examination of the rats treated with II revealed changes in the testes varying in extent and including failure of spermatogenesis and the appearance in the tubules of multinucleate giant cells. Slight desquamation of the endothelium of the convoluted tubules of the kidneys was also seen. The rats treated with III intraperitoneally showed

Table 2. Effect of Butadiene Dioxide and Vinyl*cyclo*hexene Dioxide upon the Growth of the Walker Rat Carcinoma 256

Compound	Total dose (mgm. per 100 gm. rat)	Inhibition of tumour growth (%)
Butadiene dioxide (mixed isomers) (II)	16, i.p. in oil	97
Vinyl*cyclo*hexene dioxide (III)	225, i.p. in oil	98
	375, p.o. in oil	2

essentially similar testicular changes when killed on the fourteenth day.

Single intraperitoneal doses of 25 mgm. per 100 gm. of III given to rats with Walker tumour implants of several days growth produce numerous mitotic abnormalities, including the formation of chromosome bridges and fragments, in the tumour cells.

Compounds Containing Two or Three Ethylene Imine Residues

A considerable number of these has been investigated, since it soon became apparent that in this class were to be found some of the most potent cytotoxic agents yet discovered; and in addition, activity was not confined to derivatives of any one structure but was encountered in those of various aliphatic, aromatic and heterocyclic systems. Examples are shown in Table 3, where the results of tests against the Walker tumour with a few compounds of this class are recorded. The total doses, given intraperitoneally over the first ten to twelve days of experiment, are shown, with the corresponding figures for inhibition of tumour growth at fourteen days.

Table 3. Effect of some Compounds Containing Two or Three Ethylene Imine Residues upon the Growth of the Walker Rat Carcinoma 256

Compound	Total dose (mgm. per 100 gm. rat)	Inhibition of tumour growth (%)
N : N′-Di-*cyclo*ethylenecarbamylhexamethylene diamine (IV)	0·8	97
N : N′-Di-*cyclo*ethylenecarbamyl-*p* : *p*′-diamino-diphenyl methane (V)	6·5	63
2 : 4 : 6-*tris*-ethyleneimino-1 : 3 : 5-triazine (VI)	0·11	98
N : N′-Di-*cyclo*ethylenecarbamyl-toluylene diamine (VII)	1·2	96
N : N′-Di-*cyclo*ethylenecarbamyl-chlorophenylene diamine (VIII)	8	98

Of these we consider VI to be outstanding. It is a white crystalline solid, very readily soluble in water and in most organic solvents. It is stable at room temperature but undergoes rapid polymerization on heating. It produces more than 90 per cent inhibition of the growth of the Walker tumour under the conditions of our test when given in a total dose of c. 0·1 mgm. per 100 gm. rat, intraperitoneally or intravenously, over the first ten to twelve days of experiment. By mouth some fifty times this dose is required to produce the same effect. Tumour-growth inhibition is in all cases accompanied by a moderate reduction in overall gain of body-weight.

Single doses given to rats with Walker tumours of several days growth produce cytological changes in the tumour which vary with the dose. With the smallest, 12·5–25 μgm. per 100 gm. rat, 60–80 per cent of the anaphases are abnormal in tumour tissue taken 24, 48 and 72 hr. after dosing, and show chromosome fragmentation and bridge formation. Doses of 0·1–0·5 mgm. per 100 gm. rat produce almost complete inhibition of mitosis in the tumour

up to 72 hr., and such divisions as are seen are abnormal. Essentially identical mitotic abnormalities are seen in the cells of growing *Vicia* roots 24, 48 and 72 hr. after immersion for one hour in aqueous solutions of the compound in concentrations of 10^{-5} to 10^{-6}. At 10^{-3} to 10^{-4} it completely suppresses mitosis, causes marked pyknosis of the cells, and kills some roots.

Its administration to normal animals of several species results in a fairly uniform pattern of pathological change. The lymphoid tissues are widely attacked and become depleted to a variable extent of lymphoid cells, with replacement by proliferated reticulo-endothelial cells: in some animals areas of total necrosis have been seen in the lymph nodes and spleen. Severe damage is sustained by the bone marrow and is reflected in a fall in the leucocyte count of the blood. In Feulgen-stained smears of the bone marrow, evidence is found of the suppression of mitosis, while those cells in division show many abnormalities, including 'specific chromosome effects'. Testicular damage ranges from mild changes in a few tubules in some animals to complete loss of spermatogenesis with cell desquamation and the appearance in the tubules of multinucleate giant cells in others. Necrotic changes of very variable extent are encountered in the liver and adrenal, and very occasionally in other organs.

It is clear from our results that active members of the three chemical classes mentioned have many biological properties in common. Moreover, the effects they produce are strikingly reminiscent of those attributed to the 'nitrogen mustards' (vide, for example, Gaensler *et al.*[10]). We consider that these are manifestations of a common cytotoxic action with specific characteristics. In all cases where it has been studied, their action upon proliferating cells results in the appearance of those abnormalities, chromosome fragmentation and bridge formation, that are distinctive of mitotic poisons of the radiomimetic class (cf. Loveless and Revell, *loc. cit.*).

The production by these compounds of such specific chromosome abnormalities prompted us to examine their potentialities in two other directions. A selection has now been on test as carcinogenic agents in rats and mice for periods up to one year, and some are being tested on fungal spores for mutagenic activity. The evidence for carcinogenic activity is strongest so far for the compound vinyl*cyclo*hexene dioxide (III), which has given rise to one transplantable rat sarcoma and several malignant tumours in mice, while butadiene dioxide (II) has given evidence of mutagenic activity.

Chemically, our active compounds resemble each other and the active 'nitrogen mustards' in that the molecule of each carries at least two alkylating groups capable of interaction with active hydrogen atoms. In consequence they are all potential cross-linking agents; but while this capacity appears to be necessary for biological activity, it is not a sufficient condition. Although linear bifunctional methylolamides, for example, may function as cross-linking agents, we have shown that they have no action on tumour growth. From consideration of our results it appears that only those substances are active which are capable of polymerization to yield linear structures with reactive alkylating groups spaced at intervals along the axes. With the aid of models it can be shown that these reactive groups may appear on alternating sides of the polymer chain, and at distances apart which are approximate multiples of 3·7 A. This distance corresponds nearly to the spacing of the purine and pyrimidine residues in the nucleic acids and of the amino-acids in extended polypeptides, and we conceive of such polymers, formed perhaps within the cells, providing a comparatively stable multi-point attachment on protein or nucleic acid chains, for example, those associated with sister chromatids of the dividing cell. This might well give rise to the mitotic abnormalities observed and form the basis of such biological properties as are common to all the compounds in question.

The results and speculations which we have outlined above will be published in greater detail in the near future. Although they are presented here mainly on account of their current theoretical interest, they appear to us to justify the clinical trial in human malignant disease of some of the more active of the compounds described. Such trials have already been initiated with *M*.7924 (I) and *M*.9500 (VI).

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EARLY DAYS OF GENETICS IN BRITAIN

GENETICS celebrates its jubilee this year, for it was in 1900 that Mendel's epoch-making paper was rescued from thirty-five years of obscurity and neglect. Thus the whole of the active history of genetics falls within, if only just within, the academic life-span of a man. Into this half-century has been crowded a wealth of discovery, a development of theory, and, we may well add, an interplay of personalities which it would be difficult to match during any corresponding period in any single science. The rise of genetics has been remarkable in its speed and fascinating in its turbulence. It was born in Mendel's frustration, and grew up in the strife between Bateson and Pearson, between the Mendelians and the biometricians. The tradition dies hard; but the later battles, for the chromosome theory, for parasynapsis as opposed to telosynapsis, for the interpretation of the chiasma, for the theory of the gene—and now even for genetics itself—are more recent and more familiar to us all.

The great names of the early life of genetics have, of course, all gone—Correns, De Vries, Johannsen, Wilson and the rest. Bateson died in 1926 and Pearson in 1937. Most of the younger British geneticists of the time—Doncaster, Lock and Gregory—preceded them, to the lasting detriment of genetics in Britain. Few even of the senior geneticists of to-day played any active part in those early conflicts which laid the foundation now taken so much for granted, namely, the foundation of virtually universal and virtually exclusively Mendelian (or as we should now say, nuclear) inheritance in the living kingdom. Prof. R. C. Punnett, the chief of Bateson's

collaborators, is, however, happily still with us to recall for us the story of those times in a way impossible for any but one who was an active participator. This he did in his address, "Early Days of Genetics", delivered to the hundredth meeting of the Genetical Society in Cambridge last year, and now published in *Heredity* (4, 1–10; 1950).

Prof. Punnett begins by sketching in the background of morphological Darwinism, as it was towards the end of the past century. From Galton's attempt to give precision to the notions of variation and heredity grew the biometrical school led by Pearson the mathematician and Weldon the zoologist. Theirs was the orthodoxy with which Bateson clashed: a clash which was coloured by the early association and friendship of Weldon and Bateson at St. John's College, Cambridge. This clash preceded the revelation of Mendel's paper in 1900, a revelation which, of course, confirmed Bateson in his view that variation was discontinuous and which set him off with added vigour on his experimental line of inquiry. We can read of the shifts to which Bateson and his small band were reduced by shortage of funds to support their experiments; of tending the poultry and of growing the sweet peas; of the dark business of 'openings' when unhatched chicks were taken from their eggs for classification; and of the rides to the farm for classifying the sweet peas which it was impossible to grow in Bateson's garden. The difficulties of publication, too, were serious in these early days, and the Reports to the Evolution Committee of the Royal Society (of which Bateson eventually became secretary) afforded the only free channel.

Some of the occasions of which Prof. Punnett writes have a drama seldom found at scientific meetings. The session at the British Association meeting in 1904, when the Mendelians presented their case and fought off the attacks of Weldon and Pearson, deserves almost to rank beside that other and earlier session which Bishop Wilberforce and T. H. Huxley made famous. On another occasion, at the Royal Society, Hurst's Mendelian interpretation of the inheritance of chestnut in horses was successfully challenged by Weldon from his own study of the "Stud Book", and to Bateson's intense annoyance the paper had to be withdrawn. But we can scarcely share this annoyance. We are given the story of "Ben Battle", the horse who was registered as a chestnut and who sired bays from chestnut mares; a story which teaches us not to be conservative or restrictive in our reading. For "Ben Battle", though entered in the "Stud Book" as a chestnut, was revealed by "Form at a Glance" always to have raced as a bay. Mendelism in horses was saved.

The history which Prof. Punnett relates is essentially personal, whether he is describing the conduct of experiments, the clashes with opponents, or his own association with G. H. Hardy both in the secretaryship of the Committee for the Retention of Greek in the Previous Examination and on the cricket field—an association which resulted in the formulation of Hardy's Law, upon which population genetics has been built. It is this personal element, this re-living of those early days, which lends fascination to the story. Prof. Punnett's account will appeal not merely to the geneticist interested in the rise of his science. The colour which he paints into the early genetical scene must surely command a wider audience—one which will include all biologists, for all are now feeling the repercussions of the events which he so vividly describes. K. MATHER

OBITUARIES

Mr. Henry G. Maurice, C.B.

HENRY GASCOYEN MAURICE, fisheries secretary of the Ministry of Agriculture and Fisheries during 1912–38, and former president of the Zoological Society of London, died in London on May 12 at the age of seventy-five. He was educated at Marlborough and Lincoln College, Oxford, graduating in Honour Moderations and Greats; and afterwards spent some time in coaching and travel before being called to the Bar at Lincoln's Inn in 1904. He then joined the Board of Education and, as private secretary to Sir Walter Runciman, accompanied him to the Ministry of Agriculture and Fisheries, and eventually was appointed to take charge of the Fisheries Department. At first Maurice's appointment aroused some criticism among zoologists, but his wise judgment, tactful handling of his staff, friendly and unassuming manner soon won the affection and confidence of all who came in contact with him. He was largely responsible for the formation of the Fisheries Committee of the Development Commission, and the development of fisheries research laboratories in Great Britain. He was also interested in the development of the whaling industry and the preservation of whales, and was an original member of the Discovery Committee of the Colonial Office.

Maurice was president of the International Council for the Exploration of the Sea during 1920–38, and afterwards *president d'honneur*; for his services he was awarded the Gold Medal of the Johannes Schmidt Foundation for Oceanographical Research. He served for many years on the Council of the Marine Biological Association and the Challenger Society: his address to the latter in 1945, "Where the Society stands", aptly summarizes the early history of the Challenger Society and its future possibilities.

A much wider public, however, will remember Maurice as a field naturalist. At Marlborough an interest in birds and bird-watching was stimulated by his senior school-fellow, J. Stanley Gardiner, and as a keen angler he acquired a wider acquaintance with Nature. Some years before his retirement he went to live near Regent's Park and became a constant visitor to the Zoological Gardens. He was elected to the Council of the Zoological Society in 1926, and from then onwards took a more active interest in its affairs. In 1942 he succeeded Lord Onslow as president of the Society and held this office until 1948, helping to pilot the Society through the difficult post-war period. His services were recognized by the award of the Society's Gold Medal, conferred only three times previously.

Maurice took a very active part in Nature protection, and as secretary of the Society for the Preservation of the Fauna of the Empire helped to arouse a wider interest in the subject and promote necessary legislation. He was editor of the *Fauna Journal* and one of its main contributors. As a member of the Commission of the Institut des Parcs Nationaux du Congo Belge, he expounded his views in an address given (in French) at the Fondation Universitaire, Brussels, under the title "Parle à la terre". He led the British delegation to the inaugural conference at Fontainebleau in 1948 which resulted in the foundation of the International Union for the Protection of Nature, and was one of its first vice-presidents.

Maurice possessed exceptional literary gifts and contributed reviews, letters and articles to various publications, including *The Times*, the *New Statesman*, the *Manchester Guardian*, the *Field* and *Zoo Life*. Two of his main interests are evident in his volumes "Sometimes an Angler", a collection of fishing memories, and "The Wisdom of the Ass", a series of essays on animal behaviour. A translation of his Belgian address containing a philosophical exposition of his attitude towards wild life was the subject of a leader in *The Times*. EDWARD HINDLE

Mr. M. J. B. Davy

MR. MAURICE JOHN BERNARD DAVY, keeper of the Department of Air and Water Transport at the Science Museum, London, who died in hospital on June 1 at the age of fifty-seven, was a well-known authority on the history and development of aeronautics in all its branches. Born on November 12, 1892, he was the only son of the late Lieut.-Colonel J. J. Davy. He was educated at Douai Abbey and by private tuition. In the First World War he became a pilot officer in the Royal Flying Corps, and this, no doubt, was the genesis of his devotion to aeronautics.

When he entered the Science Museum in 1920, under the directorship of Sir Henry Lyons, there was already a small embryo collection entitled "Aerial Navigation", which he, more than anyone else, laboured to develop into the present Aeronautical Collection, by general consent one of the finest of its kind in the world.

Davy's principal contributions to aeronautical history will be found in the series of official handbooks which he prepared for the Science Museum. Soon after his appointment, there appeared in 1922 the first separate catalogue of the Aeronautics Collection, to which a supplement was added in 1924. The handbook "Heavier-than-air Aircraft" appeared in 1929, and has run to several editions. There followed "The Propulsion of Aircraft" (with Mr. G. T. Richards) in 1930, a special monograph in 1931 involving a great deal of original research on the pioneer work of Henson and Stringfellow, and "Lighter-than-air Aircraft" in 1934.

Davy's approach was both that of technician and philosopher. In his major works, such as the "Interpretive History of Flight" first published in 1937, and "Air Power and Civilization" which appeared in 1941, he sought not merely to record the history of aeronautics, but also to interpret its sociological implications. This same attitude of mind is apparent in the thoughtful article "Flight in Nature and in Human Society" which he contributed in 1948 to the *Journal of the Royal Aeronautical Society*.

Davy's life work, embodied in the aeronautical collections of the Science Museum, is a testimony to his industry, enthusiasm and ability which will last so long as the Museum stands. Those who had the privilege of working with him will sadly miss a personality of great charm and the counsel of a respected colleague. He was a fellow of the Royal Aeronautical Society and an Officer of the Order of St. John of Jerusalem. H. P. SPRATT

NEWS and VIEWS

Geology at Oxford : Prof. J. A. Douglas

WITH his retirement this year from the chair of geology of Oxford, Prof. J. A. Douglas ends a distinguished association of forty-eight years in the University, commencing as undergraduate, continuing as demonstrator, and finally, in 1937, succeeding to the chair in place of W. J. Sollas, who had remained in office until his death at the age of eighty-seven. Prof. Douglas is a master in an unusual degree of all aspects of geology, and his pleasant temperament and capacity for exposition have made him a teacher who has had an important influence on geological learning at Oxford through the years. His researches have covered British Jurassic stratigraphy, palæontology and economic geology. He carried out geological exploration in the Andes of Peru and Bolivia during 1910–12 and again in 1929. He has been palæontological adviser to the Anglo-Iranian Oil Co. since 1922 and has travelled extensively in the Middle East ; and this association has supplied material for important palæontological papers. Prof. Douglas has served on the Council of the Geological Society of London for twenty years, for seven years as secretary, and twice as vice-president. He has been a fellow of University College, Oxford, since 1937. In the First World War, after serving with the Gordon Highlanders and 172 Tunnelling Coy., Royal Engineers, he was appointed instructor in military mining at Chatham. In the Second World War he commanded the Oxford City Battalion of the Home Guard.

The Department of Geology has been greatly handicapped for many years by inadequate accommodation ; but, thanks to the initiative of Prof. Douglas and financial support by the Shell Petroleum Co., a new building was completed last year and formally opened by the vice-chancellor (see *Nature*, July 23, 1949, p. 152). It is sad that Prof. Douglas has had so short a time to enjoy this excellent building ; but it will remain as a memorial to the great part which he has played in geological education in Oxford over so many years.

Prof. L. R. Wager, F.R.S.

PROF. L. R. WAGER, who succeeds Prof. Douglas, was educated at Leeds Grammar School and Pembroke College, Cambridge, where he was awarded an open scholarship in 1923. Following his B.A. degree in 1926, he worked for three years in the Sedgwick Museum, Cambridge, as a Goldsmiths' Company's research student. His work at Cambridge gave early indication of his wide interests in geology, and his researches ranged from metasomatism in the Whin Sill and metamorphism of the Connemara region to the tectonics of the Craven area. In 1929 he was appointed lecturer in mineralogy and petrology at the University of Reading, and his period there was marked by a further widening of his interests in the geological sciences, and a great extension of his field of activity. In 1930–31, as geologist to the British Arctic Air-Route Expedition, he discovered the Tertiary igneous activity of the East Greenland coast

between Angmagsalik and Kangerdlugsuak and showed that detailed studies within this area would produce results of great value. Two further visits to East Greenland followed, first with Mikkelsen in 1932, and then the British East Greenland Expedition of 1935–36, organised and led by Wager himself. Between these two expeditions he was a climbing member of the 1933 Mount Everest Expedition and took part that year in the first assault on the summit from Camp VI, becoming one of the few to have climbed higher than 28,000 ft. During the Expedition he made a geomorphological study of the Arun River drainage pattern and its relationship to the rise of the Himalayas.

It is, however, for his work in Greenland that Prof. Wager has achieved wide distinction, and here the problems gave full scope for his broad interests. His work in this field covers such diverse subjects as the form and age of the Greenland Ice Cap, the Kap Dalton sedimentary series, the East Greenland dyke swarm and crustal flexure, the stratigraphy and tectonics of Knud Rasmussen Land and the petrology of the Skaergaard Intrusion. The latter work is perhaps the most detailed and closely reasoned account of differentiation in magma of basaltic composition in the literature, and has become a milestone in the development of igneous petrology. During the War he served with distinction in the photographic intelligence branch of the Royal Air Force. Since his appointment in 1944 to the chair of geology at Durham, Prof. Wager has entered the field of geochemistry and has completed a detailed study of the distribution of the minor elements in the strongly differentiated Skaergaard Intrusion. Since 1945 he has inspired a team of research workers at Durham to undertake the re-investigation of the classical area of the Tertiary igneous activity in Skye, and it is hoped that his departure will not unduly delay the completion of this work. Prof. Wager's distinction as a geologist, explorer and mountaineer has received wide recognition. He was awarded an Arctic Medal in 1933, a Leverhulme fellowship in 1935, the Mungo Park Medal of the Royal Geographical Society in 1936, the Bigsby Medal of the Geological Society in 1945 and the International Geological Congress Spendiarov Prize in 1948. He was elected to the Royal Society in 1946.

New Harwell Electromagnetic Isotope Separator

A SECOND electromagnetic isotope separation plant has been completed at the Atomic Energy Research Establishment at Harwell and the collection of separated or enriched isotopes has started. A small electromagnetic separator has been running at Harwell for two years and has been supplying samples of isotopes of light elements for nuclear physics work. The new plant is capable of separating for experimental work gram quantities of the isotopes of the heavy elements, including uranium, at a high degree of enrichment, and the first separations were carried out in May. While the large electromagnetic plant is expected to be fully occupied on work for the Establishment for some time to come, milligram samples of the lighter elements made by the smaller plant will be made available for export, as well as for use in Britain, as supplies permit. The new plant was designed by a group of scientific workers at Harwell and was manufactured by Metropolitan-Vickers Electrical Co., Ltd., in conjunction with the General Electric Company, Ltd., and the British Thomson-Houston Co., Ltd.

Marjory Stephenson Memorial Fund

SHORTLY after the early and much regretted death of Marjory Stephenson during her tenure of office as president of the Society for General Microbiology, it was agreed at the annual general meeting of that Society on April 20, 1949, that an appeal should be made for subscriptions from members of the Society with the view of establishing a memorial. At that time it was believed that another independent memorial was being contemplated, but this project has not materialized. In view of this the Society has decided to extend the appeal to the general public so that the very wide circle of those who admired Marjory Stephenson's work or knew her as a friend or colleague may have the opportunity to contribute. It is proposed to found a Marjory Stephenson Memorial Lecture, to be given at regular intervals, possibly annually; and in selecting the lecturer the claims of the younger members of the Society will be particularly considered. The money will be used to cover the lecturer's expenses and to present him or her with a token of the occasion in the form of a medal or books. The capital sum needed will be about £1,000. Subscriptions should be sent to the National Provincial Bank, Ltd., 12 Southwark Street, London, S.E.1, and made payable to the Society for General Microbiology, No. 2 a/c.

National Institute of Sciences of India: Research Fellowships

AT a meeting of the Council of the National Institute of Sciences of India, held on May 5, research fellowships (normally tenable for two years) were awarded to the following for work in particular fields at the places shown. *National Institute of Sciences Senior Research Fellowships:* S. P. Basu (physico-chemical factors affecting freshwater fish culture), All-India Institute of Hygiene and Public Health, Calcutta; Dr. Sukh Dev (sesquiterpenes), Indian Institute of Science, Bangalore; Dr. P. B. Mathur (vitamin C in potato tubers during storage), College of Agriculture, Benares Hindu University; V. R. Thiruvenkatachar (compressible fluid flow), Central College, Bangalore. *Imperial Chemical Industries (India) Research Fellowships:* C. Balakrishnan (internal conversion coefficients of radioisotopes), National Physical Laboratory, New Delhi; Dr. I. M. Chak (preparation of hæmostatics from oil-seeds), Indian Institute of Science, Bangalore; A. G. K. Menon (ichthyological studies with special reference to zoogeography), Zoological Survey of India, Calcutta; Dr. G. C. Mitra (origin and development of the leaves and their parts at the shoot apices of Angiosperms), University of Calcutta. *National Institute of Sciences Junior Research Fellowships:* V. Chandrasekharan (light scattering in crystals and determination of elastic constants), Indian Institute of Science, Bangalore; A. K. Chaudhuri (optics of the electron gun in electron microscopy), University of Calcutta; Dr. G. S. Deshmukh (analytical chemistry of cerium and thorium), Benares Hindu University; Dr. B. D. Mundkur (heredity and variation in Ascomycetes, particularly fungi yielding antibiotics), University of Bombay; N. Satapati (petrology, petrochemistry and petrotectonics of the Eastern Ghats), Andhra University, Waltair; Dr. G. Venkatachalam (animal breeding, including animal genetics and applied statistics), Livestock Research Station, Hosur; Dr. (Mrs.) Vidyavati (anatomy of *Labeo rohita*), University of Delhi.

Applied Biology in the National Research Laboratories, Ottawa

THE Division of Applied Biology, National Research Laboratories, Ottawa, has now been in operation for twenty years and has already issued some five hundred publications. Its chief concern is research into the use of agricultural products as food or as industrial raw materials, problems connected with the productive or medical aspects of the subject being left to other organisations. The investigations undertaken cover a wide field and include those of a long-term fundamental nature as well as those for immediate industrial application. The results of the Division's activities are now being published as quarterly reports, the first of which was issued for the period January–March 1949. Each report will include a detailed account of some aspect of the work which has reached a reasonable state of completion, and will describe the chief features of the work in progress in the various fields of inquiry, such as food preservation, industrial utilization of agricultural crops and wastes, fats and oils, seaweed products and the application of statistics.

Infra-Red Heating Jackets

A NEW type of flexible heating jacket with a very wide range of uses, the 'Stabilag' infra-red heating jacket, has been marketed by Electricals, Ltd., Newcastle upon Tyne, 2. The jackets are moulded to fit any shape or size of apparatus and consist of a closely pitched heating element stitched to a fabric of woven glass in such a way that the heat is distributed evenly over the entire surface. They are normally supplied with an aluminium outer cover, although steel, stainless steel or copper can be supplied if desired, and are available for laboratory or industrial purposes. They provide a completely safe form of heating for inflammable liquids and can be used in conjunction with various types of control gear to give controlled heating to within 0·1° C. up to 500° C.

Guide to the Science Museum, London

ONE of the last administrative acts of the late Dr. H. Shaw, director of the Science Museum, South Kensington, London, S.W.7, was to publish an admirable outline guide to the exhibits (pp. 36+6 plates; London: H.M. Stationery Office, 1950; 6*d*. net). The booklet gives just that information which the average visitor requires, and is not overburdened with facts. A sketch map indicating the environs of the Museum and a plan of the galleries, together with a comprehensive index, quickly enables the visitor to discover the objects he seeks, or enables the individual with no particular object in mind to make an intelligent tour of the building. The objects for illustration have been selected with care, and the production is worthy of one of the foremost national museums in Great Britain.

Congress of Animal Technicians

A CONGRESS of animal technicians, organised by the Laboratory Animals Bureau, took place at the Royal Veterinary College, London, during March 30–31. More than four hundred technicians from all parts of Great Britain attended on one or both days. On March 30, at the congress, the Animal Technicians Association was formed under the presidency of Dr. A. S. Parkes; the honorary secretary is Mr. A. E. Mundy, Research Institute, Royal Veterinary College, Royal College Street, London, N.W.1, from whom details of the new Association can be obtained. On March 31 three scientific and technical papers were presented: "Management of Small Animal Colonies to produce Large Numbers of Litter Mates for Controlled Experiments", by Mr. G. Porter, chief technician, Rowett Research Institute, Bucksburn; "The Effect of Controlled Artificial Illumination on Rat Breeding", by Mr. R. A. Hall, chief technician, Allen and Hanburys, Ware; and "Infection in Laboratory Animals", by Dr. H. J. Parish, clinical research director, Wellcome Research Laboratories, Beckenham. On both days a programme of scientific films was presented. There was also a trade exhibition at which were represented more than thirty firms engaged in the manufacture of animal house equipment, materials, appliances and accessories. Full details of the proceedings of the congress will be published in the *Journal of the Animal Technicians Association*. The Laboratory Animals Bureau will be organising a similar congress in 1951 at a provincial centre.

International Congress of Mathematicians

AN International Congress of Mathematicians will be held at Harvard University, Cambridge, Massachusetts, during August 30–September 6, under the auspices of the American Mathematical Society. This Congress was originally intended for 1940, but was postponed owing to the War; consequently it will be the first international gathering of mathematicians to be held since the Congress in Oslo in 1936. The usual joint meeting of the American Mathematical Society, the Mathematical Association of America, and the Institute of Mathematical Statistics will be cancelled this year in favour of the Congress. The programme of the Congress is arranged primarily on the basis of conferences in four different fields, at which there will be both formal lectures and informal open discussion; the four conferences and the subjects to be considered are: *algebra*—groups and universal algebra, structure theory of rings and algebras, arithmetic algebra and algebraic geometry; *analysis*—algebraic tendencies in analysis, analysis and geometry in the large and extremal methods and geometric theory of functions of a complex variable; *applied mathematics*—partial differential equations, statistical mechanics and random processes in physics and communication; and *topology*—homology and homotopy theory, fibre bundles and obstructions, differentiable manifolds, and topological groups. In addition, there are seven sections of the Congress at which short papers may be contributed and at which a small number of half-hour addresses will be given (by invitation); these sections are: (1) algebra and theory of numbers; (2) analysis; (3) geometry and topology; (4) probability and statistics, actuarial science, economics; (5) mathematical physics and applied mathematics; (6) logic and philosophy; and (7) history and education. The official languages of the Congress are English, French, German, Italian and Russian. All communications should be addressed to the International Congress of Mathematicians, Low Memorial Library, 531 West 116th Street, New York City 27.

Nuclear Physics Conference in Great Britain

THE Atomic Energy Research Establishment at Harwell is organising a nuclear physics conference to be held at Harwell and Oxford during September 7–13. The proceedings will be divided into two parts: the first concerned primarily with the use of high-energy

particle accelerators, for nuclear physics experiments; and the second with lower-energy nuclear physics, including the use of atomic piles for experimental work. The number of delegates at the conference will be limited by the capacity of the lecture theatres to about two hundred, and attendance will be by invitation only. Delegates are expected from British universities, and from the British Commonwealth, the United States and Western Europe. The programme will be as follows: September 7–8, high-energy accelerators, experimental and theoretical high-energy physics and β-ray spectroscopy; September 9, a visit to Harwell; September 11–12, nuclear physics; and September 13, pile physics and neutron spectroscopy.

Beit Memorial Fellowships for Medical Research

Beit Memorial fellowships for medical research have been awarded to the following for work in particular fields at the places shown. *Fourth-year fellowship* (£700 a year): Dr. G. Weber (dissociation of insulin), School of Biochemistry, University of Cambridge. *Junior fellowships* (£600 a year): J. Crossland (nature and functions of humoral factors in nervous transmission in the brain), Neuropsychiatric Research Centre, Whitchurch Hospital, Cardiff; Joan E. Keilin (link between the hæm and protein in hæmoglobin), School of Biochemistry, Cambridge; R. J. Salton (chemical and immunological nature of the outer envelopes of bacterial cells), Department of Colloid Science, Cambridge.

Announcements

The Kamerlingh Onnes Gold Medal awarded by the Nederlandse Vereniging voor Koeltechniek (Netherlands Society for Refrigeration) has been conferred upon Prof. F. E. Simon, professor of thermodynamics in the University of Oxford, in recognition of his contributions to refrigeration techniques at very low temperatures. The presentation ceremony will take place in Leyden on September 21, the anniversary of the birth of the late Prof. H. Kamerlingh Onnes.

The joint committee of the Royal Physical Society, the Royal Scottish Geographical Society, and the Royal Society of Edinburgh has awarded the Dr. W. S. Bruce Memorial Prize (1950) to Dr. M. J. Dunbar, associate professor at McGill University, Montreal, for his biological researches in the Canadian Arctic.

The Summer Meeting of the Industrial Radiology Group of the Institute of Physics will be held at the New Horticultural Hall, Victoria, London, during July 25–28. Admission to the lectures and Group Summer Exhibition (and to the Technical Exhibition of the International Congress of Radiology) will be by ticket only, obtainable free from the Institute of Physics, 47 Belgrave Square, London, S.W.1.

The Manchester and District Branch of the Institute of Physics and the British Rheologists Club will hold a joint conference on the physics of lubrication at the University of Manchester during June 29–July 1. Further particulars may be obtained from the conference secretary, Mr. D. A. Crooks, Imperial Chemical Industries, Ltd., Dyestuffs Division, Hexagon House, Manchester 9.

The Midland Branch of the Institute of Physics is holding a conference on vacuum physics at the Physics Department, University of Birmingham, during June 27–28. The conference will provide an opportunity for the lecturers, all of whom are closely associated with developments in vacuum physics, to describe the most recent improvements in technique and equipment. A public exhibition will be staged in conjunction with the conference at which it has been arranged for leading manufacturers of vacuum equipment to exhibit a wide range of pumps, gauges and associated equipment. Membership of the conference is open to all who are interested in this field, and further details may be obtained from the Deputy Secretary, Institute of Physics, 47 Belgrave Square, London, S.W.7.

The National Aeronautical Collection in the Science Museum, London, S.W.7, will be re-opened to the public on June 24. The Collection is in the Western Galleries of the Museum. It contains many famous and historic aircraft, and it illustrates the history and development of aeronautics from the earliest conception of flight to the latest rocket-propelled aircraft.

The Harvard School of Business Administration and the British Institute of Management are jointly offering two scholarships for men of British nationality to study business methods and administration at Harvard for two years. One scholarship is being financed by Harvard and the other from funds contributed by British industry. The awards are worth 2,400 dollars (£860) a year and are open to those who are, or intend to pursue careers, in industry, commerce, labour organisations or the public services. Application forms (to be returned by June 30) can be obtained from the Head of the Educational Development Department, British Institute of Management, Management House, 8 Hill Street, London, W.1.

The eighth annual meeting of the Electron Microscope Society of America will be held at the Hotel Statler, Detroit, Michigan, during September 14–16. The programme chairman is F. A. Hamm, of the Central Research Laboratory, General Aniline and Film Corporation, Easton, Pa.

At the Third Congress of the International Scientific Film Association, held in Brussels during September 30–October 5, 1949, a Medical Standing Committee was set up, the chief function of which is the collection of data about existing films on human parasitology, and also the exploration of the needs of film-production in this field and the possibility of setting up a collection of such films. Medical practitioners and experts on human parasitology who are able to give some information on existing films on human parasitology (title, size, subject, country of origin and maker) are asked to write to Dr. Willem de Vogel, Netherlands University Institute for the Production of Scientific Films, 59 Catharijnesingel, Utrecht.

The University of London awards a certificate of proficiency in natural history, which is designed for teachers who require a certificate testifying that they have a practical working knowledge of the subject for children up to the age of fifteen years. The work involves a directed course of private reading at home, attendance at a four-week practical course, field-work (to be written up in an essay), and written and oral examinations. Further information may be obtained (before November 30) from the Director of the Department of Extra-Mural Studies, University of London, Senate House, London, W.C.1.

COMPARISON OF THE EAST ANGLIAN AND CONTINENTAL PLEISTOCENE

By Prof. PAUL WOLDSTEDT
Amt für Bodenforschung, Hanover

In North Germany and the adjacent regions there are found the deposits of only three glaciations: those of the Elster, Saale and Weichsel glaciations, which probably correspond to the Alpine Mindel, Riss and Würm glaciations. True glacial deposits of a still older glaciation which would correspond to the Alpine Günz glaciation have not been found in North Germany so far. The three North German glaciations are separated by two interglacial marine transgressions. Between the Elster and the Saale glaciation there is intercalated the transgression of the so-called 'Holstein Sea' which, coming from the North Sea, advanced to Holstein and possibly as far as Rügen. Beneath and upon the marine transgression there have been found continental interglacial deposits.

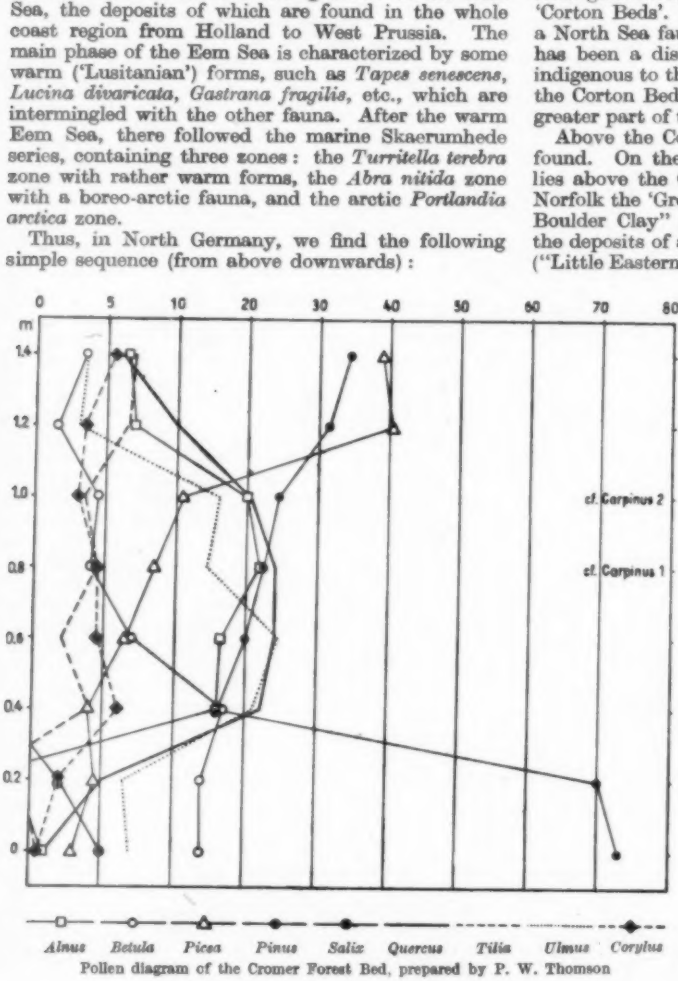
Between the Saale and the Weichsel glaciation, there is intercalated the transgression of the Eem Sea, the deposits of which are found in the whole coast region from Holland to West Prussia. The main phase of the Eem Sea is characterized by some warm ('Lusitanian') forms, such as *Tapes senescens*, *Lucina divaricata*, *Gastrana fragilis*, etc., which are intermingled with the other fauna. After the warm Eem Sea, there followed the marine Skaerumhede series, containing three zones: the *Turritella terebra* zone with rather warm forms, the *Abra nitida* zone with a boreo-arctic fauna, and the arctic *Portlandia arctica* zone.

Thus, in North Germany, we find the following simple sequence (from above downwards):

5. Weichsel Glaciation (several phases).
4. Deposits of the Skaerumhede Series
   ,, ,, ,, Eem Sea
   (continental deposits beneath and above).
3. Saale Glaciation (several phases).
2. Deposits of the Holstein Sea
   (continental deposits beneath and above).
1. Elster Glaciation.

Apart from the oldest Pleistocene deposits, which will be dealt with later on, the glacial sequence in East Anglia begins with the Cromer Till and the Norwich Brickearth. They are the deposits of the oldest glaciation which originated in Scandinavia and brought erratics from the Oslo region to East Anglia. Above the Cromer Till (and the other deposits of the same glaciation) we find the 'Middle-Glacial Sands' or 'Corton Beds'. According to Harmer[1], they contain a North Sea fauna with some northern forms. There has been a discussion whether or not the fauna is indigenous to the sands. According to Baden-Powell, the Corton Beds are true marine deposits; but a greater part of them seems to be redeposited.

Above the Corton Beds various boulder clays are found. On the Cromer coast the 'Contorted Drift' lies above the Corton Beds, in the eastern coast of Norfolk the 'Great Chalky Boulder Clay' ("Lowestoft Boulder Clay" of Baden-Powell[2]). In another area the deposits of a still younger glaciation are reported ("Little Eastern Glaciation", "Gipping Boulder Clay" of Baden-Powell). All these deposits are older than the March Gravels.



Pollen diagram of the Cromer Forest Bed, prepared by P. W. Thomson

The March Gravels, according to Baden-Powell[3], are marine sands and gravels occurring in the Fen district. The molluscan fauna, the Foraminifera and some echinoid spines indicate that this is a truly marine, not brackish-water, formation. Above the March Gravels we find a brown, occasionally stony, non-laminated clay which is supposed to be of the same age as the Hunstanton Boulder Clay, which occurs as the youngest Pleistocene formation in a narrow strip north-east of the Wash.

Thus, in East Anglia, we find the following Pleistocene sequence:

6. Hunstanton Boulder Clay.
5. March Gravels (marine).
4. Deposits of "Little Eastern Glaciation".
3. Lower Chalky Boulder Clay.
2. Corton Beds (marine).
1. North Sea Drift (Cromer Till, etc.).

The most important result is that we find in both sequences *two* marine interglacial horizons. In

both cases the lower marine horizon lies upon the deepest till complex, the upper beneath the youngest till, belonging to the last glaciation. It seems very likely that these marine horizons, which belong to widespread interglacial high-water levels of the ocean, can be correlated. In all formations marine horizons are the most reliable for correlation. Thus, the Corton Beds are supposed to be of the same age as the Holstein Sea. Further investigations will show which horizons are to be paralleled in detail.

As to the March Gravels, they have to be correlated with one of the last-interglacial marine deposits of the Continent. Certainly they are not the direct equivalent of the Eem Beds. None of the characteristic Lusitanian forms of that warm sea occurs in the March Gravels. There is a better correspondence with the later phase, namely, the Skaerumhede Series.

Between the upper and the lower marine horizon there is in both regions a series of glacial deposits which mostly shows a bipartition. In North Germany we find first the deposits of the Saale glaciation (main phase) and then those of the so-called "Warthe stage". Between these two stages there was probably an interstadial phase, in which the ice sheet possibly melted back to the Baltic Sea. The fact that there was no marine transgression in this phase indicates that it was not a full interglacial period with high water level of the ocean (cf. P. Woldstedt[4]).

Similarly, in East Anglia, traces of a marine transgression are missing from the series lying between the Corton Beds and the March Gravels. We would expect such a transgression if there had been a real interglacial period. May we not conclude from that fact that in East Anglia all the glacial deposits lying between the Corton Beds and the March Gravels belong to one greater glacial epoch, with division at the most by an interstadial phase, rather than by an interglacial period?

In the continental area, as mentioned above, undoubted glacial deposits of a pre-Elster glaciation (corresponding to the Alpine Günz glaciation) are lacking. But recently Wirtz and Illies[5] have stated that in the "Sylt Crag", which is closely connected with the East Anglian Crag, and is of lowest Pleistocene age, there are traces of a very moist, probably cold, phase. On the Continent, a few pre-Elster interglacial formations have been found, the oldest beds of which point to a preceding cold period. In Harmarnia, near Jaroslaw, in Galicia (cf. W. Szafer[6]), we find gyttja and peat beneath the deposits of the Cracovian glaciation (Elster = Mindel). The pollen diagram shows that a warm period with mixed oak forest and beech has been antedated by an older cold phase.

In East Anglia the well-known Cromer Forest Bed occurs in a very similar position. The accompanying pollen diagram was kindly prepared by P. W. Thomson on the basis of a few samples which I collected during excursion *C*-17 of the Eighteenth International Geological Congress (1948). The diagram represents mainly a mixed oak forest diminishing in the topmost sample. Still younger phases of the vegetation history are not represented in this profile. On the other hand, the flora is more and more impoverished towards the base. In the lowest sample there is mainly pollen of *Pinus* and *Betula*, besides that of *Ulmus*, *Salix* and *Picea*. Thus here also a cold phase has antedated the Cromer Forest Bed Interglacial. Actually, the considerable influx of arctic molluscs in the Weybourne Crag has been supposed for a long time to be an equivalent of the oldest glaciation (Günz).

If the oncoming of arctic molluscs in the Upper Crag series is a token of the oldest glaciation, the Cromer Forest Bed has to be interpreted as a deposit of the Günz–Mindel interglacial period, as has been supposed by most Pleistocene geologists. From this a remarkable fact results. Seen from the point of eustasy, we should expect during glaciation a low, during an interglacial period a high, level of the ocean. What we find here is the contrary: a high ocean-level during the cold period of the Upper Crag series, and a comparatively low level in the Cromer Forest Bed interglacial period. A plausible explanation of this relationship, which occurs also in the Netherlands, cannot yet be given. Possibly, in this region, we do not know the real lowest level of the ocean during the Günz glaciation. Maybe this lowest level was intercalated between the Weybourne Crag and the Cromer Forest Bed (or intercalated between the Weybourne and the Newer Red Crag ?).

East Anglia	North Germany and adjacent areas		Tentative correlation with the Alpine glaciations
	Coast region	Inland	
Hunstanton Boulder Clay Minor advance ?	Pomeranian Phase Masurian Interstadial Brandenburg Phase Rixdorf Horizon ? Minor advance ?		Würm Glaciation
March Gravels	Skaerumhede Series Eem Sea	Interglacial deposits of Herning, Brörup, Honerdingen, Rinnersdorf, etc.	Riss–Würm Interglacial
Little Eastern Glaciation Interstadial ? Contorted Drift, Chalky Boulder Clays	Warthe Phase Interstadial ? Saale Glaciation (main phase) (Varsovian I in Poland)		Riss Glaciation
Corton Beds	Holstein Sea	Interglacial deposits of Berlin (Paludina Beds), Olszewice	Mindel–Riss Interglacial
Cromer Till Norwich Brickearth	Elster Glaciation (Cracovian in Poland)		Mindel Glaciation
Cromer Forest Bed		Interglacial deposit of Hamarnia	Günz–Mindel Interglacial
Weybourne Crag with Arctic molluscs	Moist and cold period (Glaciation in Scandinavia ?)		Günz Glaciation

Perhaps extensive crustal deformations are responsible for the comparatively low modern position of the Cromer Forest Bed. But that does not alter the remarkable position of the Weybourne Crag relative to the latter. Here is a difficulty not yet solved.

The accompanying table shows the results following from the correlation carried out above. In some details they agree with the results of Boswell[7] and Zeuner[8], in other parts they differ; there is but little agreement with the table of MacClintock[9] for eastern England.

[1] Harmer, F. W., *Proc. Geol. Assoc.*, **17**, 458 (1902).
[2] Baden-Powell, D. F. W., *Geol. Mag.*, **85**, 279 (1948).
[3] Baden-Powell, D. F. W., *Geol. Mag.*, **71**, 191 (1934).
[4] Woldstedt, Paul, *Geol. Rundschau*, **35**, 23 (1947).
[5] Wirtz, D., and Illies, H., "Plio-Pleistozängrenze und Günzeiszeit in Norddeutschland: Eiszeitalter und Gegenwart", **1** (1950) (in the press).
[6] Szafer, W., *Bull. Acad. Pol. Sci. et Lettres, Cl. math. nat.*, B, 19 (1931).
[7] Boswell, P. G. H., *Proc. Prehist. Soc.*, 149 (1936).
[8] Zeuner, F. E., *Proc. Prehist. Soc.*, 136 (1937).
[9] MacClintock, Paul, Rep. **16**, Internat. Geol. Congr. Washington, 1933 (1935).

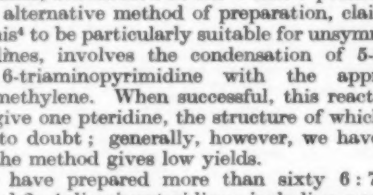
VIBRIOSTATIC ACTIVITY IN CERTAIN SERIES OF PTERIDINES

By Dr. H. O. J. COLLIER
Pharmacological Department
Dr. N. R. CAMPBELL and M. E. H. FITZGERALD
Organic Chemical Department,
Allen and Hanburys, Ltd., Ware, Herts

MALLETTE, Taylor and Cain[1] have synthesized certain derivatives of 2 : 4-diaminopteridine by the condensation of α-diketones with 2 : 4 : 5 : 6-tetraminopyrimidine bisulphite. Daniel *et al.*[2,3] have shown that these compounds inhibit the growth of *Streptococcus fæcalis*, *Lactobacillus casei*, *L. arabinosus*, *Staphylococcus aureus* and *Bacterium coli* in varying degrees. We have investigated the activity of these compounds against *Vibrio choleræ* and have also prepared and studied a number of new 2 : 4-diaminopteridines, substituted in the 6 and 7 positions.

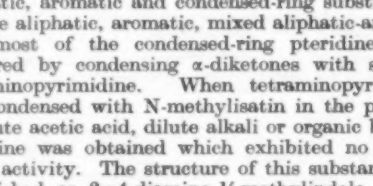
An alternative method of preparation, claimed by Timmis[4] to be particularly suitable for unsymmetrical pteridines, involves the condensation of 5-nitroso-2 : 4 : 6-triaminopyrimidine with the appropriate keto-methylene. When successful, this reaction can only give one pteridine, the structure of which is not open to doubt; generally, however, we have found that the method gives low yields.

We have prepared more than sixty 6 : 7-disubstituted 2 : 4-diaminopteridines, including many with aliphatic, aromatic and condensed-ring substituents. All the aliphatic, aromatic, mixed aliphatic-aromatic and most of the condensed-ring pteridines were prepared by condensing α-diketones with salts of tetraminopyrimidine. When tetraminopyrimidine was condensed with N-methylisatin in the presence of dilute acetic acid, dilute alkali or organic bases, a pteridine was obtained which exhibited no vibriostatic activity. The structure of this substance was established as 2 : 4-diamino-1′-methylindolo (2′ : 3′-7 : 6)-pteridine (I) by obtaining the same material on condensing 5-nitroso-2 : 4 : 6-triaminopyrimidine with N-methyloxindole. A similar reaction with N-methyl-O-acetylindoxyl[5] gave the other, vibriostatic, isomer,



I

Non-vibriostatic isomer



II

Vibriostatic isomer (0/120)

which must accordingly be 2 : 4-diamino-1′-methylindolo(2′ : 3′-6 : 7)-pteridine (II). A mixture of products, of varying activity, resulted from condensations of tetraminopyrimidine with N-methylisatin in the presence of mineral acid.

All compounds prepared have been examined for vibriostatic activity by the methods recently described by Collier, Hall and Waterhouse[6]. Below we give examples of the results obtained with some of these techniques.

The *in vitro* activities of some of these compounds are exemplified in Table 1, which gives the minimal concentration of pteridine in peptone water at *p*H 7·2 sufficient to inhibit for 24 hr. at 37° C. the growth of an inoculum of 10^3 vibrios (*V. choleræ* Madras 48210) per ml. In these conditions, the compounds synthesized by Mallette *et al.*, with the possible exception of the very sparingly soluble acenaphtho derivative, show little activity. Some members, however, of each series described above possess considerable vibriostatic powers. In the series of 2 : 4-diamino-6 : 7-dialkylpteridines, activity is greatest in the di-*iso*propyl compound (0/129). The di-*sec.*-butyl (0/142), the di-ethyl (0/69) and the di-*n*-propyl derivatives are slightly less active than this, and compounds with longer or shorter alkyl chains are far less active.

Table 1. *In vitro* activities in peptone water at 24 hr. of some 6 : 7-disubstituted, 2 : 4-diaminopteridines alone and mixed with sulphaguanidine. In brackets, values in a synthetic medium after 40 hr. incubation

Serial No. of compound	Substituents	Minimal inhibitory concentration (μgm. per ml.)	
		Substance alone	Mixture of 10 per cent pteridine and 90 per cent sulphaguanidine
0/69	6 : 7-di-ethyl	40	40
0/129	6 : 7-di-*iso*propyl	10 (5)	10 (5)
0/142	6 : 7-di-*sec.*-butyl	40	40
0/61	6 : 7-di(*p*-methoxyphenyl)	20	20
0/159	6(or 7)-ethyl-7(or 6) *p*-methoxyphenyl	40	40
0/120 (II)	1′-methylindolo-(2′ : 3′-6 : 7)	2·5 (3)	5 (5)
	6 : 7-di-methyl	>640	
	6 : 7-di-phenyl	>640	
Sulphaguanidine		>640 (9)	

In the 6 : 7 di-aryl series both the di(*p*-methoxy phenyl) (0/61) and the di-furyl derivative show considerable activity. Some cyclic derivatives also exhibit activity, for example, a camphano-pteridine and certain indolo-pteridines. The N-methylindolo pteridine mentioned above (0/120) shows the highest activity of all compounds tested. The low activity of sulphaguanidine in peptone water is due presumably to the presence of sulphonamide antagonists, since

Table 2. Results of administering to mice pteridines, sulphaguanidine and mixtures of pteridine with sulphaguanidine in the diet for three weeks

Compound	Fæcal vibriostatic titre		Maximal dietary percentage of pure substance tolerated
	Substance alone (dietary percentage in brackets)	0·4% pteridine + 3·6% sulphaguanidine in diet	
0/129	<80 (0·4)	1,280	0·8
0/61	<80 (0·4)	320	0·2
0/120	320–640 (0·4)	2,560–5,120	0·8
Sulphaguanidine	160 (4·0)		

this drug inhibits the growth of vibrios satisfactorily in a synthetic medium.

Three of the pteridines, 0/61, 0/120 and 0/129, have been administered to mice in their diet at various concentrations over periods of three weeks. The maximal dietary concentration of each pteridine tolerated by eight out of ten animals is expressed in Table 2.

The fæces of mice feeding upon these experimental diets were collected, suspended and serially diluted in peptone water, autoclaved and sown with *V. choleræ* in the manner already described in detail (fæcal suspension test[4]). In this test the highest dilution capable of inhibiting the growth of vibrios is called the 'fæcal vibriostatic titre'. As an example, we give in Table 2 the titres obtained when fæcal suspensions were sown with 10^3 vibrios per ml. and incubated at 37° C. for 24 hr. It will be seen that 0/120, administered at 0·4 per cent in the diet, confers a high titre upon the fæces. The titre conferred by a diet containing 0·4 per cent of this pteridine is higher than that conferred by a diet containing 4 per cent sulphaguanidine, and the difference is even greater when the fæcal suspensions are inoculated with 10^6 vibrios per ml.

Since Daniel and Norris[3] have reported synergism between pteridines and sulphonamides, our more active compounds were examined for synergism with sulphaguanidine, which has been reported to be of clinical value in cholera (see Pasricha *et al.*[7]).

We have obtained good evidence of synergism, since, for example, in peptone water, under the same conditions of test as described above, a 10 per cent mixture of pteridine in sulphaguanidine exhibited a vibriostatic activity equal to that of the pure pteridine and far greater than that of sulphaguanidine alone (see Table 1). If incubation of the test cultures is continued for longer than 24 hr., the mixture considerably excels the pure pteridine in capacity to inhibit the growth of vibrios. 0/120 is a partial exception to this observation. It does, however, synergize to some extent with sulphaguanidine, as is seen in Table 1 and in the mouse experiments described below.

Mixtures of 10 per cent pteridine in sulphaguanidine were administered to mice in the diet. This was done by admixing in the diet 0·4 per cent pteridine and 3·6 per cent sulphaguanidine. The titres conferred by the pteridine–sulphonamide mixture, as is seen in Table 2, are considerably higher than those conferred upon the fæces by either pteridine or sulphonamide alone. Chemical estimations of pteridines in the fæces support the view that the synergism shown in this table is real.

In mice the intraperitoneal *LD* 50 of the phosphates of pteridines 0/120 and 0/129 lies between 100 and 150 mgm. per kgm. However, in mixtures of pteridine 0/120 with sulphaguanidine, the ingredients are not synergic but additive in their intraperitoneal toxicity. Moreover, in mixtures of pteridine 0/129 with sulphaguanidine the ingredients are neither synergic nor additive in their intraperitoneal toxicity.

We have found that a number of these compounds, such as 0/61, 0/69 and 0/120, powerfully inhibit the growth of *Strep. fæcalis*. In each instance the inhibitory effect on this organism is overcome by pteroylglutamic acid. This is consistent with the observations of Daniel and her co-workers on other compounds.

It is intended to publish shortly fuller accounts of the work upon which the above conclusions are based.

It is a pleasure to express our thanks to Dr. Cain for supplies of the 6 : 7-dimethyl- and 6 : 7-diphenyl-2 : 4-diaminopteridines. We also wish to thank the directors of Allen and Hanburys, Ltd., for permission to publish this work.

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[6] Collier, H. O. J., Hall, I. F., and Waterhouse, P. D., *Ann. Trop. Med. Parasitol.*, **43**, 155 (1949).
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THE MIDLAND COKE RESEARCH STATION

THE Midland Coke Research Station of the British Coke Research Association was formally inaugurated on May 4 by the Earl of Halifax. The Research Station, where problems on the production and utilization of coke from coke ovens are investigated, is in Clarkehouse Road, Sheffield, 10, about one mile from the centre of the city, and is conveniently close to the main buildings of the University of Sheffield and the University's Department of Fuel Technology in St. George's Square.

The Association was incorporated on June 20, 1944, as a grant-aided research organisation under the Department of Scientific and Industrial Research. Before that time, research on hard coke, that is, coke produced by carbonization of coal in oven chambers, had been carried out independently by the Midland, Northern and Scottish Coke Research Committees. These worked from their laboratories at Sheffield, Newcastle upon Tyne and Glasgow, respectively, and were controlled by regional committees representative of coke users, producers and other interested local organisations.

With the incorporation of the Association, the financing of research for the coking industry was undertaken by the British Coking Industry Association, and centralized control and co-ordination of research activities on coke became the responsibility of the council of the British Coke Research Association. The Association immediately undertook certain measures of reorganisation and drew up a comprehensive programme intended to cover the research work on coke for some years ahead, and to make full use of the facilities and staffs available in Sheffield and Newcastle.

It is apparent that the coking industry is located in certain well-defined regional areas, determined in large part by the availability of coking coal, and it is therefore not surprising to find that during the past twenty-five years the research work undertaken on coal and coke has acquired distinctly regional characteristics. The Association decided to encourage these characteristics by retaining the research establishments already existing at Sheffield and Newcastle and by promoting further research into local problems at Glasgow. In order to secure closer co-operation between the regional research workers and more intimate liaison with the operating technicians of the industry, it was agreed that a system of panels should be set up to deal with certain specific items in the research programme, and that these

panels should consist of members drawn from both sources. Although it was considered an innovation at the time of adoption, this system has proved both practicable and valuable to the research workers and the operating technicians alike.

The Association also decided at an early stage of its existence that it was most desirable to continue the system whereby work of an academic and long-term nature should be undertaken at the universities on behalf of the Association. This decision, since proved to be well justified, has resulted in a tendency to concentrate the academic and long-term researches of the industry at the laboratories of the Northern Coke Research Committee in King's College, Newcastle upon Tyne.

The Midland Coke Research Station has been developed concurrently from laboratories which were originally placed at the disposal of the Midland Coke Research Committee by the University of Sheffield. The Committee was formed in 1926 and was located in the Department of Fuel Technology until 1946, when, owing to increasing and insistent demands upon the available space, the University was reluctantly compelled to terminate this very generous arrangement. In view of the formation of the national body, the Midland Coke Research Committee decided that it should cease to function after the end of 1946, and the Association then agreed to establish its own research station in the Sheffield district, taking over the research staff who had worked hitherto for the Midland Coke Research Committee. Thus, from the earliest days of research on hard coke, there has been a long and valued connexion with the University of Sheffield, a connexion which the Association is proud to continue and which has proved to be of very great benefit to the cause of coke research during the past quarter of a century.

The Association approached the Sheffield Corporation in its quest for suitable premises in which to accommodate the Midland Coke Research Station. The Corporation, which has always been keenly concerned in furthering matters affecting the interests of the basic industries centred in and around Sheffield, agreed to grant the Association the lease of a detached house owned by the Corporation and known as 'Lynwood', situated in its own grounds. The situation, facilities and amenities at 'Lynwood' render the Station very suitable for the type of work the Association is undertaking in Sheffield. The premises required some adaptation for the purposes of research, and this work was undertaken without delay. By the end of 1948 most of the structural alterations had been completed, and a start was made in equipping the buildings for research. On the ground floor are situated the superintendent's office and staff rooms, the general office and the library. Arrangements were made with the Coke Oven Managers' Association whereby its library was transferred to the Midland Coke Research Station, and became the property of the British Coke Research Association while being freely available to all members of the industry. Also on the ground floor are coke stores and a boiler test house. On the first floor, chemical and physical research laboratories were set up, together with a balance room, calorimetry room and chemical store; a general analytical laboratory was also established on this floor. A photographic department, stores and an electrical workshop were set up in the basement. The outbuildings have been converted into use as laboratories and workshops for various purposes. A laboratory has been provided for testing coke-burning appliances, and this has been equipped with means for carrying out efficiency and other tests on open grates, stoves, domestic hot-water boilers and small central-heating installations. The sampling and grinding arrangements available at the Station constitute probably the most efficient means yet devised for obtaining for purposes of analysis representative samples of finely ground coke from bulk consignments.

The research programme of the Association, which has been approved by the Department of Scientific and Industrial Research, covers the major problems facing the industry, and has been planned so that there is no unnecessary duplication of work with other organisations engaged on similar problems in fuel research, such as the Fuel Research Station, Gas Research Board and others. One of the major undertakings before the industry is the immense programme of reconstruction and repair which is at present in progress. It is important that the coke-oven batteries now being constructed should incorporate all the latest improvements and facilities available, and the Association, in conjunction with the principal British coke-oven construction organisations, has already made studies of such items as oven dimensions in relation to coal and coke qualities, and has investigated practical points of construction which are likely to improve the life of ovens, reduce operating and maintenance costs and give improved standards of working conditions. Close contact has been maintained with the progress of coke-oven plant design in the principal countries overseas engaged in this work.

It is well known that there is a shortage of the best-quality coking coals, and it is essential that these supplies should be conserved. This can be done only by extending supplies, which entails blending strongly caking coals with others of somewhat lower value. This problem is thus receiving special consideration, and the blending of high-quality coals with durain, fusain, coke dust, anthracite, pitch and tar have all been considered. A specification for an ideal plant lay-out to give full blending facilities has been devised. It is important that consumers of hard coke should receive the types of coke which are most suited to their needs, and investigation continues into means of producing the ideal coke for the three main purposes of blast furnace, foundry, and industrial and domestic use.

Coke produced for the iron and steel industry must have as low a sulphur content as possible; but unfortunately the sulphur content of the coking coals now being produced is increasing, and serious attention is being given to the possibility of reducing the sulphur content of coke by any possible means. For domestic use it is important that a coke be obtained which is convenient for household use, and this involves a control of the reactivity of the coke, together with the determination of the most suitable sizes for particular appliances.

It will be clear that many of the problems mentioned above require investigation on an industrial scale and are inappropriate for work in the laboratory. The station at Sheffield is primarily concerned with those matters which can be dealt with satisfactorily in the laboratory. One such major field is the development of chemical and physical tests of all types. Although the British Standards Institution publishes standard methods for the measurement of various quantities, it is not always convenient for industry to carry out the standard tests. Moreover,

certain of these tests may be impracticable for normal works-control because of the time required for completion. Consideration has been given by the Association at the Research Station to the determination of analytical methods which will give the required accuracy together with rapid results.

Certain other tests especially required for the coking industry have not been standardized as yet by the British Standards Institution. A case in point is a test for the float and sink analysis of coal, and details of a method based on work carried out at the Station have been published. Considerable attention has been given also to means of screening coke, a problem which is by no means as straightforward as would appear.

Inquiries relating to the Association and its work should be addressed to the Director, British Coke Research Association, 74 Grosvenor Street, London, W.1.

SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES

ANNUAL CONGRESS

AT the invitation of the Mayor and Corporation of Richmond and of the president and Council of the Richmond Scientific Society, the South-Eastern Union of Scientific Societies held its fifty-fourth annual congress at Richmond during June 5–10.

The president was Dr. J. Ramsbottom, keeper of botany, British Museum (Natural History). The title of his presidential address was "The Biology of Peace". Dr. Ramsbottom reminded his audience that his previous address, given at Guildford in 1942, had for its subject "Fungi and the Biology of War", and that it was chiefly concerned with combating the idea that war is a biological necessity and that there were pure races of man pre-ordained for pre-eminence. The purpose of the present address was to put forward some ideas of the biology of peace. War of itself is of no biological use to man, though it must be granted that in the stress of two world wars there has resulted an accelerated development in the theory and application of science, both physical and biological, and the present 'cold war' is not without its influence in intensifying research. The pity of it is that fear and distrust among nations should have such a disproportionate influence on progress of any kind. No matter what his philosophy, the man of science is dealing with what might be generalized as the phenomena of Nature, the discovery of the laws which govern the universe, and the intrinsic nature and properties of its constituents. There have been repeated warnings about the danger of a world food shortage. Fundamentally, the problem resolves itself into the number of people and the amount of food. Populations continue to increase and we are unable to produce sufficient food or timber for our use.

Man should not represent himself as against the world—*Homo contra mundum*—but of it. Every organism is affected by its environment and in its turn affects it: indeed, it is best to regard an organism as part and parcel of its environment, and man, biologically, is an organism. The complex which we signify by the term environment has a theoretical stability, a climax. In Great Britain the vegetation climax is a forest; but it is sometimes overlooked that it is the whole community signified by the term forest —trees, shrubs, herbs, mosses, liverworts, algæ, fungi, lichens, bacteria and a similar gamut of the animal kingdom; in short, the whole complex of organisms above, on and under the ground.

Dr. Ramsbottom proceeded to stress the need for the protection of the countryside and the preservation of species. When once a species is exterminated it is lost for ever. Destruction is not confined to shooting and trapping, it is inevitable if the habitat is greatly altered. In schemes for preservation the climatic, edaphic and biological factors must be understood. Biological factors include man's activities.

The problems relating to world food supplies are such that they have to be studied from all angles: integration of research to prevent disintegration of our future. We have modified above and below the earth's crust, we have been profligate in our actions, but mankind still manages to survive. Continuing, Dr. Ramsbottom remarked that to make a few suggestions of simple remedies would savour of an election address of an illiterate demagogue. There is no universal panacea for human ills, be they spiritual, physical or economical. With all our efforts, be they ever so well directed, shall we be able so to balance our industrial and agricultural matters that we produce sufficient food and timber for our needs? One solution which has been suggested for Great Britain is to reduce the population. Emigration of one-third of the population of Britain to other parts of the Commonwealth would save enormous capital and natural resources. Dr. Ramsbottom said that he confessed to an undaunted optimism, for where danger lies, there also grows the saving power. Great Britain may not remain so powerful in a naval, military and air sense, but there is no danger of it becoming a desert and so no possibility of it being written off as derelict. Indiscriminate felling of forests, fires, overgrazing, continuous single crops, lack of the use of fertilizers and the untethered goat all have their effect on the vegetation, fertility and cohesion of the soil and lead to erosion and deserts. Mistakes have been made, but it should not be beyond the powers of man to turn the tide and even repair the damage. It must not be overlooked that algæ, and particularly fungi, can supply us with supplementary proteins and other foods. Gastronomic salvation may be by way of flowerless plants, but the monotony of the diet would possibly mean the loss of one type of man—the gourmet.

The members of the Congress were received by the Mayor of Richmond (Councillor P. H. Keene) who, in his welcome, spoke of the value of science to the community. A young naturalists' evening was arranged, and questions were answered by a team of experts with Major Maxwell Knight as the question master, and an exhibition of Nature films was arranged by Mr. Douglas Fisher.

Addresses were delivered to the Archæological, Botanical, Geological and Zoological Sections and excursions carried out by these Sections daily. Colour films of botanical expeditions to Thibet were shown by Dr. George Taylor.

The final address was by Mr. E. J. King, of the Department of Extra-Mural Studies, University of London, on "The Scientific Societies and the University". In speaking of the mutual advantage of co-operation between universities and societies, he stressed that academic interest must not interfere with general interest and enthusiasm. The general

tendency of the university is towards technical and professional education, often for the purpose of examinations, enabling the scientific and natural history societies to provide, in addition to opportunities for research, the scientific background for those who wish to stand and stare. In this work his own Department could, and is anxious to, co-operate.

By a happy coincidence it was announced during the Congress that the award of O.B.E. had been conferred upon the president of the Richmond Scientific Society, Miss E. M. Wakefield, deputy keeper of the Herbarium and chief mycologist in the Royal Botanic Gardens, Kew, for her services to science.

STANDARDIZATION OF UNITS OF MEASUREMENT IN CIVIL AVIATION

By W. J. V. BRANCH

Air Navigation Commission, International Civil Aviation Organisation, Montreal

LAST year it was announced that the Montreal headquarters of the International Civil Aviation Organisation had obtained agreement on a plan to standardize the dimensional units used in air/ground communications in civil aviation and that this agreement has been implemented by a considerable number of countries (see *Nature*, July 2, 1949, p. 17). It is as yet impossible to say what final success this plan will have; but it is of interest to note some trends which are developing in the process of its implementation, and the following table shows the percentage of countries which have adopted units of the Organisation.

PERCENTAGE ADOPTION (BY COUNTRIES) OF THE FINAL I.C.A.O. (WORLD STANDARD) UNITS

		per cent
(1) Distances	Nautical miles	74
(2) Horizontal speed	Knots	74
(3) Wind direction and speed	Degrees and knots	89
(4) Altimeter setting	Millibars	89
(5) Temperature	Centigrade	95
(6) Time	24 hours, the day beginning at midnight G.M.T.	100
(7) Altitudes, aerodrome dimensions and short distances	Metres	55
(8) Vertical speed	Metres/second	55
(9) Cloud height	Metres	55
(10) Visibility	Metres or kilometres	58
(11) Weight	Kilogram	57

These figures refer to countries of which the practices in this respect are officially known; for example, the figure of 74 per cent for the distance units represents only thirty-two countries. It must also be emphasized that these figures do not necessarily reflect accurately the relative frequency with which the various units are used, since the percentages are related to countries and do not take into account the relative contributions and importance to world aviation of each of the countries. Thus, though the available records show that only 12 per cent of the countries employ statute miles for the measurement of distance, the statute mile is nevertheless widely used for this purpose, since one of the countries using it, the United States, accounts for a very large percentage of the air miles flown.

It would seem that the first six units listed are quite certain to gain final world adoption. Probably the most interesting trend is the widespread agreement to use nautical miles and knots as the units for distances and horizontal speed—a clear indication of the desire of the metric countries, which would, of course, prefer to use kilometres, to co-operate in this experiment. It seems probable that even in those countries which have not yet adopted these two units, the gradual pressure of world practice, the extent of which is indicated by the figure of 74 per cent, will lead to its adoption in countries which do not at present use these units.

An examination of the last five units shown in the table indicate that in their case the final position is much less certain. Generally speaking, the difficulty in adopting these units arises from the proposal to use metres in place of feet, and the continued vitality of the foot unit in opposition to a great deal of scientific opinion is quite remarkable. The outcome of the struggle between the foot and the metre will probably decide, for a considerable time, whether the world can agree on a single system of units for one of its most international services, that is, aviation, or whether there will have to be at least two major systems of units in general use.

EARTHQUAKES DURING JANUARY–MARCH

DURING the first quarter of 1950 there were four earthquakes of instrumental magnitude 7 or greater, sixteen of magnitude 6–7, and numerous smaller shocks. The four with magnitude 7 or greater occurred on January 2 in the Queen Charlotte Islands region ($M = 7$); on January 12 in the Fiji Islands region ($M = 7$); on February 28 off the north coast of Hokkaido, Japan ($M = 7\frac{1}{2}$); and on March 27 off the south coast of Sumatra ($M = 7$). Fortunately all these had epicentres in uninhabited places, and only the Japanese shock was felt. Also during the three months three earthquakes had foci at depths of 500 km. or deeper, seven had foci of 100–500 km., and the rest had shallower foci. The three deep-focus earthquakes occurred on January 12, as mentioned above, in the Fiji Islands region ($d = 500$ km.); on February 23 in the Sea of Okhotsk ($d = 500$ km.); and on March 16 again in the Fiji Islands region ($d = 600$ km.).

Many minor shocks were felt during the three months. During January the following earthquakes and tremors were felt: on the 3rd of the month at Andinclaroby, Madagascar (Modified Mercalli Scale intensity 4); on the 4th in central Italy; and on the 6th in Lisbon. On January 9 at 19h. 40m. 33s., G.M.T., an earthquake with epicentre near lat. 51·1° N., long. 1·9° E. was felt at several places along the Straits of Dover. People at Dover felt a severe tremor; and at St. Margaret's Bay, Kent, a slight tremor was felt and a noise like an explosion was heard, while at Deal doors and windows rattled and people felt chairs move. On the other side of the English Channel the tremor was felt at Calais where also plates were shaken from tables; but the tremor was not felt at Dunkirk or at Boulogne. On January 13 a tremor was felt at Mansourah-Les-Biban, Algeria (*M.M.* intensity 4); on the 16th of the month one was felt at Bucharest (*M.M.* intensity 4); on the 21st another in Central Chile; and on the 29th one was experienced at Walliser–Hochalpen (*M.M.* intensity 4). On January 31 an earthquake with epicentre at lat. 43° N., long. 0° 13′ E. near Campan in the Hautes

Pyrénées was felt strongly (*M.M.* intensity 7) at Beaudéon and with lesser intensity at other places near by.

During February the following earthquakes and earth tremors were felt: on the 22nd of the month at Stoss in Mittelwallis (*M.M.* intensity 5); on the 25th in the Iles Ithoque and Leucade (*M.M.* intensity 4); on the 26th with slight damage at Ventura, California; and on the 28th, as already mentioned, off the north coast of Hokkaido, Japan. During March earthquakes were felt at the following places: on the 7th at Ilo-Ilo in the Philippine Islands; and on the 8th at Coblenz, Bonn, Cologne, Andernach and in the Ahr Valley. The earthquake of March 7 occurred at 02h. 07m. 46s., G.M.T., from a focus having an epicentre at lat. 10° N., long. 124° E.; it had instrumental magnitude 6¾.

Collective reports have been received from the central stations at Strasbourg, Washington, D.C. (United States Coast and Geodetic Survey) and Zurich; and individual reports from the observatories at Belgrade, Cleveland (Ohio), De Bilt, Durham, Kew, Pasadena, Perth (Western Australia), Stuttgart, Toledo and Trieste.

PREPARATION OF SPECIMENS FOR THE ELECTRON MICROSCOPE

THE primary physical advantage of the electron microscope lies in its greatly increased resolving power, as compared with other forms of microscopy. Hence it finds a place as a research tool, supplementary to optical methods, in all those fields of investigation and routine testing which involve the examination of details smaller than a micron in extension. In the ten years or so since it became generally available, it has found innumerable applications. There are now about five hundred instruments in use throughout the world, in a variety of laboratories, but mainly in those engaged in biological and metallurgical research. A correspondingly wide variety of preparative techniques has been devised, and these must meet the special limitations imposed by the low penetration of electrons in matter and the consequent necessity of using specimens rather less than the wave-length of light in thickness and of desiccating them before observation. Great advances have been made since the Second World War, especially in the cutting of very thin sections of biological material and in preparing replicas of massive specimens, such as metals.

Until now, no collected account has been available of these techniques of electron microscopy, although there have appeared several works on the instrument itself. The omission has been due partly to the difficulty of treating a subject which is in rapid development, and partly to the great breadth of field to be covered. The need for such a compilation was discussed by the Electron Microscopy Group in 1945, and on the proposal of Sir Charles Darwin it was decided to initiate a collective effort towards its production. Dr. D. G. Drummond, of the Shirley Institute, Manchester, was entrusted with the task of editing it. The co-operation of the chief laboratories in Great Britain engaged in electron microscopy was readily obtained, and it was possible to circulate a typescript draft for criticism by the end of 1947. It was used in the summer schools in the subject held in the Cavendish Laboratory, Cambridge, in 1948 and 1949, and benefited from this 'pilot run' as well as contributing greatly to the success of the courses. The editor then prepared an enlarged and amended version, which has now been published as the March issue of the *Journal of the Royal Microscopical Society**, an arrangement which has permitted a high standard of production at a moderate cost. The editor and Society are to be congratulated on the appearance as well as on the content of the monograph in its final form.

Systematic treatment is accorded to the techniques which are basic to most applications of the electron microscope, followed by detailed attention to individual special fields: small particles, micro-organisms, surface replicas, tissues, sectioning and staining. There is also a short consideration of the most important instrumental matters: the determination of magnification and resolving power, and photography. The text is thus obviously of the greatest value to users of the instrument, but it will also be of interest to the non-specialist, in showing what is now possible of examination. For example, replica methods are now applicable not only to metals, but also to the surfaces of ceramic materials, porous materials such as wood, biological tissues, and crystals, including those of proteins. Similar progress has been made in the cutting of biological sections sufficiently thin (0·1–0·2 micron) for electron microscopy, through refinement of the existing types of microtome and attention to embedding-materials and cutting-temperature.

The scope of the book is confined to preparative methods and related techniques. It does not attempt to deal with the operation and maintenance of the electron microscope, a subject on which there is at present no manual. Nor is it concerned with the range and significance of the researches so far carried out with it. However, these aspects are well discussed in the "Symposium on Metallurgical Applications of the Electron Microscope" (Monograph and Report Series No. 8, Institute of Metals) and in R. W. G. Wyckoff's "Electron Microscopy", which deals mainly with biological work.

In its chosen field, the new manual fulfils admirably an important gap. In addition, its appearance is significant in showing how far the increasing complexity and range of application of scientific techniques may be reduced to order and interpreted by collective effort. Such a work is and could only be produced by some form of co-operation—and a form which is rather different from the team-work which is now usual on large research projects. The activity of the Electron Microscopy Group has comprised the practical teaching of the subject in the summer school, which is to be repeated this year, as well as the compilation of "The Practice of Electron Microscopy"; a comprehensive bibliography has also been assembled, by similar collaborative methods, and will shortly be published. If it has to be said that the instrument itself was invented and perfected in Germany, and that the United States possesses the greatest number of them, it is yet creditable that Great Britain is foremost in the exposition of such a widely useful technique, which has extended the resolving power of optical methods almost to atomic dimensions. V. E. COSSLETT

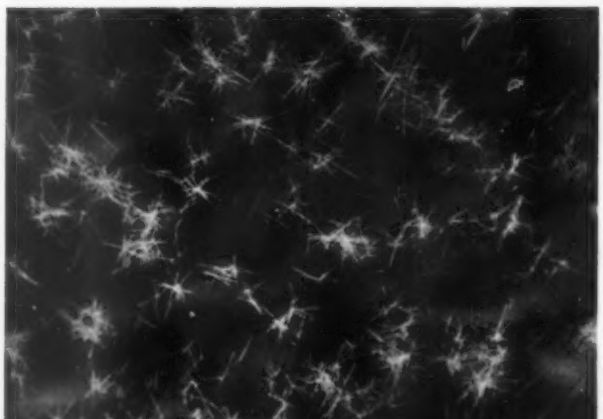
* The Practice of Electron Microscopy. Edited by D. G. Drummond for the Electron Microscopy Group of the Institute of Physics. (London: Royal Microscopical Society, 1950.) 21*s*.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

2-Hydroxypyrimidine

THAT 2-hydroxypyrimidine, a simple derivative of a much investigated series, should be incorrectly described in the literature is unexpected. Nevertheless, the properties attributed to this substance by Johnson and Joyce[1], the only workers who have claimed its synthesis, make it unlikely that it has ever been prepared. As the 2-hydroxy-group is present in the biologically important pyrimidines (cytosine, uracil, thymine), it is important to have authentic 2-hydroxypyrimidine available for the interpretation of spectra and for biochemical and biological comparisons.



Crystals of 2-hydroxypyrimidine (half actual size)

Accordingly, 2-aminopyrimidine, a substance of well-established constitution, was submitted to alkaline hydrolysis, and gave a white, highly crystalline substance (see photograph), melting at 178–180° and very soluble in water. These properties are what might be expected for a mono-hydroxypyrimidine. They bear no relation to the yellow amorphous substance, infusible at 320°, and sparingly soluble in water, described as 2-hydroxypyrimidine by Johnson and Joyce solely on the basis of a nitrogen analysis of the hydrochloride from which it had been liberated by sodium hydroxide (this hydrochloride was obtained by the acid hydrolysis of 2-ethylmercaptopyrimidine).

The new substance, of melting point 178–180°, could also be prepared, although in lower yield, by the action of nitrous acid on 2-aminopyrimidine. It analysed satisfactorily (C, H and N), as did also its picrate. It could also be recovered in a state of purity on liberation from the hydrochloride.

Sodium hydroxide solution (10 *N*; 100 ml.) was heated under reflux with 2-aminopyrimidine (10 gm.) for 12 hr. at 120° (bath temperature) with occasional agitation. Water (100 ml.) was added and the *p*H adjusted to 4–5 with 5 *N* sulphuric acid. The mixture obtained by evaporation to dryness was powdered, and extracted by refluxing and stirring for 20 min. with ethyl acetate (3 litres). The residue after hot filtration was re-extracted with ethyl acetate (1 litre). On refrigeration, the filtrates deposited 6·7 gm. (66 per cent) of crude 2-hydroxypyrimidine with melting point 178–180°. In another experiment, methyl*iso*butyl ketone (150 ml./gm. of 2-aminopyrimidine) was used instead of ethyl acetate, and although the gradient was less favourable, the same product was obtained. Recrystallization from ethyl acetate (450 ml./gm.) or ethanol (10 ml./gm.; 90 per cent recovery) gave clusters of colourless needles up to 2 cm. long. The 2-hydroxypyrimidine, after drying at 115°, had melting point 178–180° (found: C, 50·1; H, 3·9; N, 29·15; $C_4H_4ON_2$ requires C, 50·0; H, 4·2; N, 29·15 per cent). It was readily soluble in less than two parts of cold water and in ten parts of boiling ethanol, but virtually insoluble in benzene and light petroleum. It has a pK_a (basic) of 2·24 ± 0·04 (*M*/10) and pK_a (acidic) of 9·17 ± 0·06 (*M*/100).

The hydrochloride (from 50 parts of ethanol) formed feathery aggregates of colourless needles with melting point 200–205° (dec.); Johnson and Joyce gave 203–205°. The picrate (from 90 parts of ethanol) formed yellow plates of melting point 199° (found: C, 37·1; H, 2·2; N, 21·5; $C_{10}H_7O_8N_5$ requires C, 36·95; H, 2·2; N, 21·5 per cent).

The absorption spectra were determined in aqueous solution at *p*H 13, 6·1 and 0·3 respectively, using the Hilger 'Uvispek' photo-electric spectrophotometer (2×10^{-5} *M*; 4-cm. cells). The mμ and log ε values were respectively: anion 290, 3·66; neutral molecule 299, 3·66; cation 309, 3·75. Each species also showed a second, completely separated peak the maximum of which lay below 225 mμ. These spectra closely resemble those of 2-hydroxypyridine and 2-aminopyrimidine.

D. J. BROWN

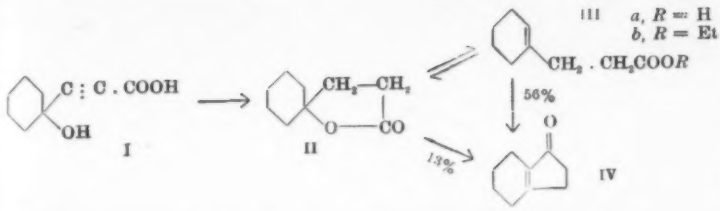
Department of Medical Chemistry,
Australian National University
(183 Euston Road, London, N.W.1).
May 23.

[1] Johnson and Joyce, *J. Amer. Chem. Soc.*, **37**, 2163 (1915). Cf. Beilstein's "Handbuch", 4th ed., **24**, 1st supp., 231.

4 : 5 : 6 : 7-Tetrahydroindan-1-one

THE appearance of a paper by Johnson and Hunt[1] prompts us to place on record the results of a closely related number of experiments. The work was undertaken to explore the possibility of converting the readily available β-*cyclo*hexanolpropiolic acids[2] to hydrindanones.

β-(1-hydroxy*cyclo*hexyl)propiolic acid (I) on reduction with Adams's platinum oxide gave γ-(*cyclo*hexyl)*spiro*butyrolactone (II), treatment of which with acetic anhydride – zinc chloride gave 4 : 5 : 6 : 7-tetrahydroindan-1-one (IV) in 13 per cent yield. The *spiro*lactone treated with thionyl chloride, then ethanol, followed by removal of the elements of hydrogen chloride[3], afforded ethyl *cyclo*hexenylpropionate (III*b*). Saponification gave β-(*cyclo*hexenyl) propionic acid (III*a*) in poor yield, the structure of which was proved by comparison of its *p*-bromphenacyl ester with that of a sample synthesized by Arndt



Eistert homologation of *cyclo*hexenylacetic acid. Ring closure of β-(*cyclo*hexenyl)propionic acid (III*a*) to 4 : 5 : 6 : 7-tetrahydroindanone with acetic anhydride–zinc chloride proceeded in 56 per cent yield.

Substance	Conditions	Products
γ-(*cyclo*hexyl) *spiro*butyrolactone (II)	Potass. bisulphate, 200° C., 45 min.	14% acid 80% lactone
	Anhydrous oxalic acid, 200° C., 1 hr.	16% acid 80% lactone
	Reagent *A* 4 hr.	2% acid 94% lactone
	,, *A* 8 ,,	2% acid 93% lactone
β-(*cyclo*hexenyl) propionic acid (III*a*)	Reagent *A* 4 hr.	30% acid 65% lactone
	,, *A* 8 ,,	10% acid 82% lactone

The position of equilibrium of the lacto-enoic tautomerism II ⇌ III*a* has also been established under certain conditions; our results agree with those of Johnson. The above series of reactions is being examined with substituted *cyclo*hexanones, and the results will be communicated elsewhere in due course.

One of us (D. W. M.) wishes to thank the University of London for the award of an I.C.I. Fellowship, during the tenure of which the above work was carried out.

W. H. Linnell
D. W. Mathieson
School of Pharmacy, University of London,
17 Bloomsbury Square, London, W.C.1.

[1] Johnson and Hunt, *J. Amer. Chem. Soc.*, **72**, 935 (1950).
[2] Haynes and Jones, *J. Chem. Soc.*, 505 (1946).
[3] Cason, Adams, Bennett and Register, *J. Amer. Chem. Soc.*, **66**, 1764 (1944).
[4] Johnson, Peterson and Sneider, *J. Amer. Chem. Soc.*, **69**, 74 (1947).

Mean Restoring Forces of Hydride Di-Atoms and their Positive Ions

I have recently published[1] the periodic table of deuteride di-atoms and their positive ions, thus completing a programme initiated by the periodic classification of the elements[2], and of non-hydride[3] and hydride[4] di-atoms according to electron configurations. In a forthcoming communication[5], I propose to examine in the light of these tables a suggestion made by Dadieu and Kohlrausch[6] that the 'mean restoring force' of a linkage may be used as a measure of bonding strength. The authors found that for C—C, C=C and C≡C linkages the mean restoring forces were closely in the ratio 1 : 2 : 3.

The mean restoring force of a di-atom is measured by $K = 1{,}878\ \sqrt{\mu}\omega_e^2$, whereas the bond constant is $k_e = 3{\cdot}550 \times 10^{23}\ \mu\omega_e^2$ (c.g.s. units). It is thus found that K generally changes from one case to another in the same sense as k_e and D_e (dissociation energy), and is a periodic function for hydrides. I have indicated that K appears to be a suitable magnitude for comparing changes in binding force in considering the effects of formation of singly charged positive ions from the corresponding hydride or deuteride, and as a measure of the increasing stability of di-atoms in a given period with increasing group number: for example, in the KH period from Li^+H^- to F^-H^+.

An interesting and apparently general principle has emerged from this work, to the effect that stability increases on ionization when the hydrogen atom lies at the negative end of the dipole, that is, for hydrides near the beginning of a period, and decreases when it is at the positive end, for hydrides of elements on the right of the periodic table. In the middle groups, the changes in stability are correspondingly small. The positive and negative effects are apparently greatest in the KH period in Groups II (LiH) and VIII (FH) respectively, and least in Group V (CH). They also increase from one period to the next in the same group. The accompanying table shows the percentage change in mean restoring force of hydrides *A*H on ionization for cases where data are available.

Period	Group number and atom *A*				
	II	III	IV	VII	VIII
HH	H −62·3				
KH		Be +13·2	B +4·5	O −29·5	
LH		Mg +21·1	(Al −6·7)		Cl −15·3
MH		Zn +30·1			
NH		Cd +45·9			
OH		Hg +77·6			

In an earlier communication, Walsh[7] noticed the drop in binding strength of OH and BrH on ionization, as judged by changes in internuclear distance. This observation is now brought into line with a general scheme. The large drop in stability in passing from HH → HH^+ is doubtless connected with the setting up of a one-electron linkage. The other changes are satisfactorily explained by Walsh's polarity theory, to the effect that increasing stability accompanies decreasing polarity, and *vice versa*. The theory must be confined to changes of polarity of the same two atoms involved in a linkage. It is not applicable to account for changes of stability from CH to FH, where both stability and polarity increase. These changes may be referred instead to the increasing positivity of the hydrogen atom.

The small changes in K for BH and AlH shown in the above table suggest a still smaller value for CH → CH^+. In the middle of a period, ionization may involve a slightly polar bond reversing its dipole, with only a small attendant change in stability. This possibly also happens in the CH bond from CH_4 to C_2H_4, where only a small change in internuclear distance (1·094 to *circa* 1·087 A.) occurs[7,8]. A fall in internuclear distance is linked with rising mean restoring force and increasing stability.

C. H. Douglas Clark
Department of Inorganic and
Physical Chemistry,
University of Leeds. Feb. 22.

[1] Clark, C. H. Douglas, *Proc. Leeds Phil. Soc.*, **5**, 244 (1949).
[2] *Idem*, *ibid.*, **2**, 225 (1931); **3**, 281 (1936).
[3] *Idem*, *ibid.*, **2**, 502 (1933); *Trans. Farad. Soc.*, **31**, 1017 (1935).
[4] *Idem*, *Proc. Leeds Phil. Soc.*, **3**, 218 (1936).
[5] *Idem*, *ibid.* (in the press).
[6] Dadieu, A., and Kohlrausch, K. W. F., *J. Opt. Soc. Amer.*, **21**, 286 (1931).
[7] Walsh, A. D., *Trans. Farad. Soc.*, **43**, 60 (1947).
[8] *Idem*, *J. Amer. Chem. Soc.*, **68**, 2408 (1946).

Hydrolysis of Osmium Compounds

THE chemical determination of the atomic weight of osmium made by Gilchrist[1] in 1932 gave the value of 191·5. This result was accepted internationally until Nier[2] calculated the value 190·2, now accepted as the international value, from mass spectrographic data. The method used by Gilchrist involved the ignition of ammonium hexabrom- and hexachlor-osmate IV in hydrogen to osmium metal. The ammonium hexahalogenates were crystallized several times from 7 or 10 per cent halogen acid.

The possibility of hydrolysis during crystallization to the hydroxy pentahalogenates which would lead to high values for the atomic weight was discounted by Gilchrist on the basis that both the compounds at either acid concentration gave concordant results. It might be pointed out that the difference in the two acid concentrations is not great enough to affect noticeably the extent of hydrolysis; and further, since the chloro compound can be expected to hydrolyse more than the bromo compound, the differences in the osmium content consequent on partial hydrolysis would be nearly identical.

Mellor[3] noted subtle differences in the colours of specimens of ammonium hexabromosmate used for magnetic measurements and suggested that the high atomic weight by the chemical method might be due to hydrolysis.

While investigating the colorimetric micro-determination of osmium, we noted that the osmium content of ammonium bromosmate seemed to vary with the previous history of the specimen. To confirm the observation, pure ammonium hexabromosmate was prepared by dissolving pure osmium tetroxide in 50 per cent hydrobromic acid at room temperature, precipitating with cold saturated ammonium bromide solution, and washing with ice water and absolute alcohol. The substance was dried in vacuum over concentrated sulphuric acid. Portions were afterwards crystallized once from various concentrations of hydrobromic acid, and dried as before. The osmium content was found by ignition in ammonia gas at 450°.

Material	% Osmium
Pure (theoretical)	26·95 (calc. from at. wt. of Os = 190·2
$(NH_4)_2$ $OsBr_6$	27·08 (calc. from at. wt. of Os = 191·5
Crystallized from 50% HBr	26·97; 27·01
Crystallized from 10% HBr	27·12; 27·11
Crystallized from 1% HBr	28·37; 28·28

It is of interest to note that specimens crystallized once from 1 per cent hydrobromic acid, then several times from 50 per cent acid, did not change in osmium content, suggesting that, as with the corresponding ruthenium compound, the hydrolysis is not easily reversed. From the analyses for bromine and osmium the substance is hydrolysed approximately 50 per cent by crystallization from 1 per cent hydrobromic acid. The crystal structures of these partially hydrolysed materials, which appear to be homogeneous, are at present being examined.

F. P. DWYER
N. A. GIBSON

Department of Chemistry,
University of Sydney,
Sydney.
Feb. 1.

[1] Gilchrist, *J. of Res., U.S. Bur. Stand.*, **2**, 279 (1932).
[2] Nier, *Phys. Rev.*, (II), **52**, 885 (1937).
[3] Mellor, *J. Roy. Soc. N.S.W*, **77**, 145 (1943).

Constitution of Ferri-Phenol Complex in Solution

OUR knowledge as to the constitution of the coloured compound formed by the interaction of phenol with freshly prepared ferric chloride solution is very meagre. Brode and Wesp[1] suggested that the violet-red colour is probably due to an ion of the type $[Fe(OPh)_6]^{-3}$; but they have not presented any evidence in its favour. We have studied the reaction by four different methods: thermometric, conductometric, absorption and transport measurements. Thermometric and conductometric titration curves of phenol with ferric chloride solutions show two breaks corresponding to Fe^{+3}: phenol equal to 1 : 3 and 1 : 6; so these may be supposed to represent the formation of the compounds $Fe(OPh)_3$ and $H_3[Fe(OPh)_6]$. By applying Job's method of continued variation, it is found that, for equimolecular solutions, the maxima in the optical density curve against the volume of one of the reactants appear at the point Fe^{+3} : phenol equal to 1 : 3. The maxima of the curves are found to be independent of the wave-length (490 μ, 550 μ) and the concentration of the reactants used, and so are due to the formation of the compound $Fe(OPh)_3$. Now the compound $Fe(OPh)_3$ may also be formulated as $Fe[Fe(OPh)_6]$, in which case also the ratio of Fe^{+3} : phenol is equal to 1 : 3. When ferric chloride – phenol solutions are shaken with non-polar organic solvents, the coloured compound is not found to be partitioned between the two liquid phases, and this supports the formulation of $Fe(OPh)_3$ as $Fe[Fe(OPh)_6]$. Finally, transport experiments by Duval's apparatus with solutions containing ferric chloride and phenol in the ratio 1 : 3 show that iron goes to the anode and thus give additional and direct evidence in favour of the formulation $Fe[Fe(OPh)_6]$.

Further studies with other phenols and phenolic acids are in progress and the results will be published soon.

Our thanks are due to Prof. P. B. Sarkar for his interest and for laboratory facilities.

SUKUMAR BANERJEE
BARUN CHANDRA HALDAR

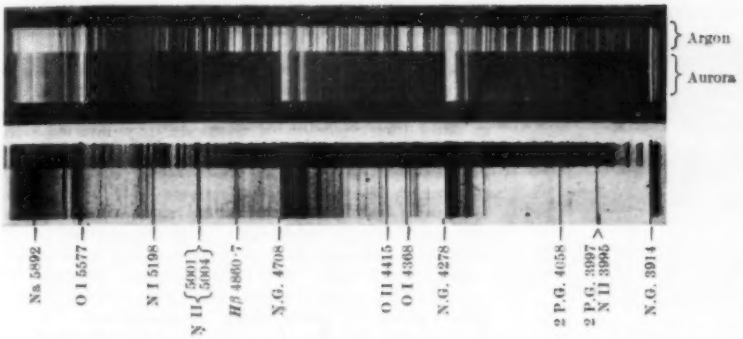
Ghose Professor's Laboratory of Chemistry,
and Inorganic Chemistry Laboratory,
University College of Science and Technology,
92 Upper Circular Road, Calcutta 9, India.

[1] Brode, W. R., and Wesp, E. F., *J. Amer. Chem. Soc.*, **56**, 1037 (1934).

An Auroral Spectrogram Obtained at Oslo on February 23

UP to the present at Tromsoe and Oslo we have observed and measured about 170 vibrational bands and atomic lines in the auroral luminescence; but only the somewhat stronger ones have been obtained with spectrographs having a dispersion sufficiently great to give the wave-length with the accuracy wanted for a reliable identification of the lines.

On spectrograms of fairly small dispersion a number of lines have been seen to exist, which are not well separated, but form more or less continuous bands. For spectral analyses, particularly of the weak lines and bands, I have got a large new spectrograph, which was built in accordance with my specifications by the Société Générale d'Optique of Paris. This spectrograph, which is very accurately made, combines a high light-power with a dispersion so great that the wave-length of a sharp line



can be measured with an accuracy of less than one angström.

With this spectrograph, and using a Kodak 103 *aT* plate, we obtained at Oslo a spectrogram from a quite brilliant auroral display which appeared during the night of February 23–24 this year. From the accompanying somewhat enlarged reproduction, we notice that, in addition to the green line and the negative nitrogen bands, a large number of the weaker lines appear, which are very distinct and sharp. A table giving the wave-lengths of the observed lines will be given in a subsequent paper. Only some outstanding results will be given here.

From the spectrogram (covering the region between about 3900 and 6300 A.) we have measured 114 lines and vibrational bands, 54 of which have not been previously observed.

Vibrational bands of the following band-systems have been measured. The negative nitrogen group (N_2^+), the 1st and 2nd positive group and Vegard–Kaplan bands originating from molecular nitrogen. But in addition we have for the first time been able to observe and measure bands belonging to the negative oxygen group originating from O_2^+. A few of the Goldstein bands of nitrogen may possibly also be present. Further, a number of lines have been found to coincide with molecular hydrogen lines.

The great accuracy with which the wave-length values can be found has made possible a reliable and unambiguous interpretation of a large number of atomic lines.

In the accompanying table we have given the number of lines originating from neutral and singly ionized nitrogen and oxygen atoms. The second column gives the number of lines n_o, for which no other possible interpretation has been found; the third column gives the number (n_c) of cases where a line may coincide with other bands or lines:

Origin	n_o	n_c
O I	8	4
O II	15	10
N I	7	2
N II	18	3

These results show that molecules and atoms of oxygen and nitrogen are present in the ionosphere in the neutral and ionized state.

We direct attention particularly to the appearance of the following atomic lines in the auroral luminescence:

(1) The line 5198·3, which appears very distinctly, is identical with the N I-doublet (5197·7, 5200·8) resulting from the forbidden transitions ($^4S_{3/2}$—$^2D_{5/2,3/2}$) of the neutral nitrogen atom.

(2) The fairly strong broad line which we have interpreted as a doublet (5001·4, 5003·7) corresponds to a group of N II-lines in the interval (5001–5005). The nebular line O III (5007) was not observed on this spectrogram.

(3) In accordance with previous measurements, we observe a fairly strong line with a wave-length exactly equal to that of the O I-line 4368·3.

It is interesting to notice that the O II-lines found on this auroral spectrogram are just the same as I have obtained from oxygen canal-rays.

The $H\beta$-line is broad and diffuse and has its maximum somewhat displaced by Doppler effect towards shorter waves, indicating rapid downward motions of the hydrogen atoms.

The rotational components of the *R*-branch of the negative nitrogen band 3914 are distinctly separated. This involves a more accurate determination of the ionospheric temperature than was previously possible from spectrograms with a continuous *R*-branch. The temperature determinations gave the following results:

$$T_m = 219{\cdot}9^\circ \text{ K. and } T_\varkappa = 217{\cdot}9^\circ,$$

where T_m is derived from the position of the intensity maximum, and $T_\varkappa$ from the intensity distribution, which is supposed to follow Maxwell's law. This gives an ionospheric temperature of -54° C., in good agreement with our previous determinations.

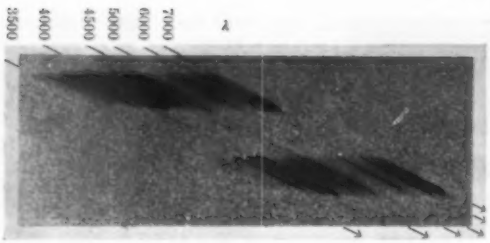
L. Vegard

Physical Institute,
Oslo. April 28.

Spectrum of a Meteor Train

It is a well-known fact that a bright meteor may leave in its path a faint enduring luminosity termed the persistent train. In the past, no photographic evidence as to the nature of this luminescence has been secured.

On August 13, 1949, at 3 hr. 20 min. U.T., during the co-operative programme of meteor observation being carried out by the Dominion Observatory and the National Research Council at Ottawa, a bright Perseid meteor of visual magnitude −4 was well observed by photographic, radio and visual methods. This meteor appeared blue and had a train which remained visible in the bright moonlight for 11 sec., while the radar echo on 30 megacycles per second lasted for 110 sec. A good spectrum was photographed on Eastman 103*aF* emulsion with Camera "*A*"[1], dispersion 450 A./mm. at $H\gamma$. This spectrograph was equipped in this case with a rotating shutter covering the lens ten times per second, the period of occultation being twice the exposure. Any enduring train bright enough to be photographed will appear in the trail-breaks produced by such a shutter. Direct photographs of the meteor show the train clearly over 0·5 sec. of path-length, and faint photographic evidence of the train spectrum appears over 0·3 sec. of the meteor's path. The accompanying reproduction shows the brightest part of the train spectrum.



The meteor train spectrum appears between the bright segments of the meteor spectrum. The very faint lines [too faint for good reproduction.—Editors] may be visible on looking along their length. Wave-lengths are given in angstroms; the direction of the motion of the meteor is indicated by arrows

The spectrum of the meteor itself, about forty bright lines, is typical of other Perseid spectra photographed[2], showing neutral iron, calcium, magnesium and sodium; and ionized calcium, magnesium and silicon. The excitation in this spectrum, photographed over a total path-length of 1·0 sec., builds up with time, the ionized lines becoming relatively stronger towards the end. This agrees with previous observations[3,4]. The train spectrum consists of four to six faint lines extending across the entire shutter break, indicating a minimum duration of 0·05 sec. after the head of the meteor has passed; and some additional short lines appearing at the edge of the break immediately behind the meteor head, duration 0·01 sec. Accurate wave-length determinations are difficult owing to the faintness of the lines and the diffusion and drift exhibited by all trains. Approximate wave-lengths, together with the suggested identifications, are listed in the accompanying table.

Spectrum Lines Observed in a Meteor Train

Wave-lengths of train lines		Relative intensity	Identification
dur. > 0·05 sec.	dur. < 0·01 sec.		
3740 ?		very weak	Fe I (21)* $a^5F - y^5F^o$
3840		strong	Mg I (3) $3^3P^o - 3^3D$
			Fe I (20) $a^5F - y^5D^o$
	3890		Fe I (4) $a^5D - z^5D^o$
			Fe I (20) $a^5F - y^5D^o$
	3930		Fe I (4) $a^5D - z^5D^o$
			Fe I (20) $a^5F - y^5D^o$
	4050		Fe I (43) $a^3F - y^3F^o$
	4130		Fe I (43) $a^3F - y^3F^o$
4230		medium	Ca I (2) $4^1S - 4^1P^o$
4410		medium	Ca I (4) $4^3P^o - 4^3D$
			Fe I (41) $a^5P - z^5G^o$
5190		weak	Mg I (2) $3^3P^o - 4^3S$
5900 ?		very weak	Na I (1) $3^2S - 3^2P^o$

* Numbers in brackets are the multiplet reference numbers from Dr. C. E. Moore's multiplet table (ref. 5).

The two chief differences between the spectrum of the meteor and that of its train are the complete absence of ionized lines in the train (Ca II is the strongest feature of the meteor spectrum), and the relative enhancement in the train of the neutral magnesium and calcium lines and the neutral iron lines arising from transitions to levels higher than the ground-state of the atom. Both these features lend support to the hypothesis that the luminosity of the train is a recombination spectrum involving chiefly the elements common in the light of the meteor. Preliminary measures of the height of this train, made from direct photographs taken at two stations, give a height-range of 85–70 km. above sea-level, the brightest part of the train being at 83 km. This value is near the lower limit of the mean height-range of luminous meteor trains observed at night and is very close to the mean height reported for noctilucent clouds.

In 1932[1], I reviewed all previous visual work on the spectra of meteor trains and concluded that the nineteenth-century observers were probably correct in their identification of the sodium yellow and the magnesium green lines in the light of meteor trains. It was also noted that when these features were present in the head of the meteor they appeared in the train, but with much lower intensity; and that the chief change with time in the spectrum of the train was a steady drop in intensity, the weaker lines disappearing first. The photographic evidence reported here corroborates the general conclusions drawn from the early visual observations. There is no support for the conclusions of Trowbridge[6] and his identification of the nitrogen afterglow in meteor trains.

In conclusion, it may be noted that the meteor discussed here is probably the most completely observed individual meteor yet recorded. A detailed study of all the radio, photographic and visual observations will appear later.

Peter M. Millman

Dominion Observatory,
Ottawa, Ont.
March 4.

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[4] Millman, P. M., *Astro. J.*, **54**, 177 (1949).
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Nuclear Resonance and Magnetic Field Changes of 1 in 10^6

It is well known[1] that when a nuclear magnetic resonance signal is obtained in a rapidly rising magnetic field, the nuclei continue precessing after resonance is passed. Their precessional frequency increases with the magnetic field, and while doing so forms beats with the exciting radio-frequency. These beats appear as 'wiggles' after passing the main resonance. In a perfectly homogeneous field, these wiggles die away exponentially at a rate determined by the relaxation time T_2[2]. T_2 is related to the natural line-width by the relation $T_2 = 1/\gamma\Delta H$, where ΔH is the line-width and γ the gyromagnetic ratio of the nuclei being used. If the magnetic field is inhomogeneous by more than ΔH over the sample volume, say by ΔH, then the rate of decay of the wiggles is generally believed to be determined by the time,

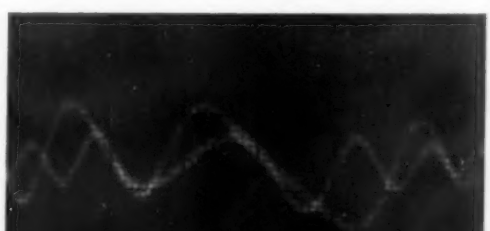

Fig. 1

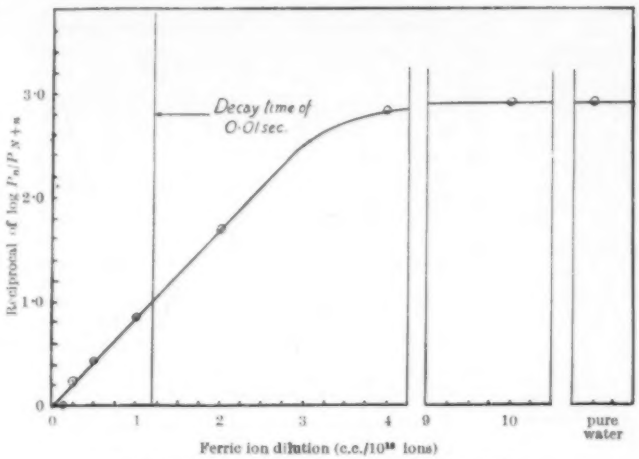

Fig. 2. Variation of 'wiggle's' decay with ferric ion dilution

$\sim 1/\gamma\Delta H$. This has proved a limitation in the measurement of transverse relaxation times $T_2 \gg 10^{-2}$ sec., as for such measurements a magnetic field inhomogeneity of $\lesssim 0{\cdot}003$ gauss is required; and, hitherto, this requirement has not been satisfied. Torrey[3] has proposed and used a method in which long relaxation times T_2 can be studied in the presence of an inhomogeneous magnetic field. The observation of his phenomenon depends on maintaining the magnetic field at resonance, and is quite unrelated to the 'wiggles' experiments.

The purpose of this note is to report another experiment from which it appears that relaxation times can be measured in the presence of an inhomogeneous field. By using this new method, it is possible also to detect changes of magnetic field of 1 in 10^4, and possibly of as little as 1 in 10^5 or 10^6.

A magnetic field of 1,060 gauss was modulated at 50 c./s. by an amplitude of ~ 10 gauss. Samples of water with ferric ammonium sulphate added were chosen, and the solution made very weak so that the relaxation times T_2 should be $\gtrsim 0{\cdot}01$ sec. The radio-frequency coil was about 1 cm. diameter and 1·1 cm. long. By suitable adjustments of the radio-frequency magnetic field ($2H_1$), and the rate of sweep through resonance, signals as shown in Fig. 1 were obtained. This shape is explained, as with ordinary wiggles, by assuming that the magnetic moments are left spinning after resonance is passed. The precessional motion continues, the signal passing outside the band-width of the receiver (100 kc./s.), and reappearing, still precessing, on the return of the magnetic field sweep. The wiggles on both halves of the sweep are visible for about 2 gauss from resonance, the continuous change in amplitude being due to the receiver band-width. During one half-period of the sweep, the amplitude has been reduced by some damping process which is independent of the inhomogeneity of the magnetic field.

Assuming that the relaxation times T_1 and T_2 are inversely proportional to the concentration of the ferric ion in the region under discussion (10^{18} Fe^{+++}/c.c.), then it is found that for a wide range of ferric ion concentrations, the damping of the oscillations is proportional to T_1 and/or T_2. This is demonstrated in Fig. 2, where (P_n/P_{N+n}) is the ratio of the amplitudes on the outgoing sweep to those on the return sweep, at the same magnetic field. For very weak concentrations and pure water, the decay reaches a limit (of about 25 per cent), probably governed by some other inhomogeneity not yet understood (cf. Torrey[3]). That the effect observed is independent of the inhomogeneity is demonstrated by distorting the field. Although the signal can be reduced in size by a factor of 10, the ratio (P_n/P_{N+n}) remains unchanged to within the experimental error of $\pm$ 10 per cent.

The magnetic moments cannot be precessing completely freely all the time, as the decay is also dependent on the radio-frequency magnetic field $2H_1$, and on the rate of change of magnetic field. For sufficiently small values of $2H_1$ ($\sim 10^{-2}$ gauss), the ratio (P_n/P_{N+n}) increases with H_1 until a broad maximum is reached with $2H_1 \sim 10^{-2}$ gauss. The maximum is reached for larger values of H_1 when the rate of change of field is greater, but all maximum values of (P_n/P_{N+n}) are roughly equal. A final property of the effect is that the time taken to obtain a signal appears to be $\sim T_1$. If the magnetic field is suddenly changed a little, the effect disappears, reappearing in a time $t \sim T_1$. Very small abrupt changes in the magnetic field cause the pattern on the return stroke to break up and re-arrange itself. In fact, field changes of 1 in 10^6 can be detected in this way. The average rate of precession is about 4·5 Mc./s., so that during 0·01 sec. the magnetic moments have spun 45,000 times. Thus a field-change of 1 in 10^6 would bring about, after 0·01 sec., a phase change in the spinning magnetic moments of $\approx 15°$ relative to the constant exciting radio-frequency. The fact that such a change is observed, together with the time of recovery being $\sim T_1$, seems to imply that the spinning is only loosely held in coherence in some way by the radio-frequency. If field-strengths of 10,000 gauss are used, and if relaxation times T_2 of ~ 1 sec. exist, as is suspected, then this mechanism could possibly be used to detect field changes of as little as 1 in 10^9.

It seems that in this particular case there is not yet an explanation of why the decay is independent of the main field inhomogeneity. Torrey's theory does not help in understanding cases where the magnetic field departs from resonance by more than H_1, whereas the effect occurs for departures from resonance of as much as 200 H_1.

J. S. Gooden

Nuffield Laboratory,
Physics Department,
University of Birmingham.
Feb. 27.

[1] Bloembergen, Purcell and Pound, *Phys. Rev.*, **73**, 679 (1948).
[2] Jacobsohn, B. A., and Wangsness, R. K., *Phys. Rev.*, **73**, 942 (1948).
[3] Torrey, H. C., *Phys. Rev.*, **76**, 1059 (1949).

Dr. Gooden was unable to read the proofs of this letter before his return to Australia, where he has since died. We are uncertain as to the correctness of the "decay time of 0·01 sec." in Fig. 2, but feel that this does not detract from the general information contained in the communication.

J. W. Blamey
W. I. B. Smith

Disintegration of Neon by Fast Neutrons

In a previous paper[1] an investigation is described in which the yield of $(n\alpha)$ and (np) reactions in nitrogen was measured using neutrons of different energies, provided by the D + D reaction.

A similar experiment has now been carried out with neon. Reactions $^{20}_{10}Ne$ $(n\alpha)$ $^{17}_{8}O$ were detected. The yield showed definite peaks at 2·47, 2·96 and probably somewhat above 3·3 MeV. neutron energy.

Method. A large proportional counter, filled with neon (unseparated) at a pressure of two atmospheres was used. Pulses were amplified and registered photographically on a film strip. The pulse size is proportional to the ionization and therefore to the energy released in the counter. By comparing pulses with those from polonium α-particles of known residual range, the corresponding energies were determined.

The counter was irradiated by neutrons from the D + D reaction. A thin heavy-ice target was bombarded by deuterons with an energy of 450 keV. In the (dn) process 3·30 MeV. is released[2]. The neutrons emitted are mono-energetic, but their energy depends strongly on the angle φ between their path and the beam of deuterons. This can be calculated from the laws of conservation of energy and momentum. In our case, the neutron energy in the forward direction (φ = 0°) is 3·5 MeV., in the backward direction (φ = 180°) 1·9 MeV. The counter was placed in various positions between φ = 120° and φ = 24°; thus the neutron energy was varied between 2·2 and 3·4 MeV.

The number of neutrons emitted in one particular direction during the time of measurement was determined by a boron fluoride proportional counter. From this the emission in other directions was calculated with the aid of the function $1 + A\cos^2\vartheta$, which gives the angular dependence of the neutron intensity in the centre of gravity co-ordinate system ($A = 1{\cdot}7$ in our case[2]). The boron trifluoride counter was calibrated by measuring the response to a 90-mgm. radium + beryllium source, placed close to the target.

Results. For various positions of the neon counter, and consequently for different neutron energies, pulses were registered and the pulse-size distribution determined; two of them are given in Fig. 1.

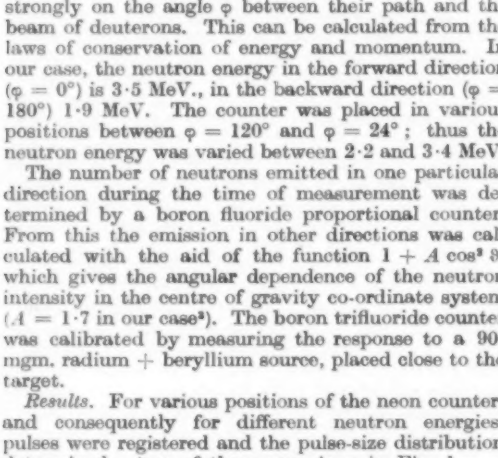

Fig. 1. Pulse-size distribution from the neon-filled proportional counter in two positions

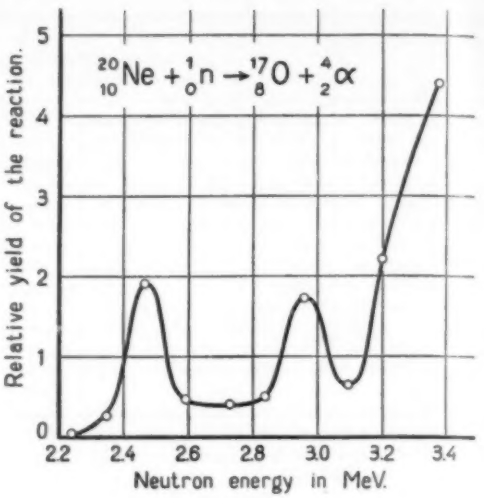

Fig. 2

One well-defined group of pulses is observed in most positions. The corresponding energy is always 0·6–0·7 MeV. less than the neutron energy. Hence these pulses must be ascribed to the process $^{20}_{10}Ne$ $(n\alpha)$ $^{17}_{8}O$, with the residual nucleus $^{17}_{8}O$ in its ground-state. According to the mass values, this process is 0·6 MeV. endoergic[4], which has been confirmed by direct measurement[5]. It is apparently the only process occurring in a noticeable measure in neon at these energies. The origin of the background is not quite clear. Apparently there is no connexion with the neon reactions. One possible explanation is a small percentage of hydrogen or helium in the filling gas of the counter.

The number of $(n\alpha)$ reactions, taken from the pulse-size distributions by subtracting the background, is plotted as a function of the neutron energy (Fig. 2). This number has been corrected to a same number of neutrons passing the counter. The uncertainty (statistical errors and uncertainty caused by the background) may be estimated as about 25 per cent when the relative yield is high, and as about 50 per cent when the yield is small. The units of the vertical axis correspond to a cross-section of about 1×10^{-24} cm.^{2}. Maxima appear at 2·47 and 2·96 MeV. neutron energy. The rapid increase of the yield on the high-energy side suggests the presence of another one at 3·4 MeV. These maxima indicate resonances leading to excited states of the intermediate $^{21}_{10}Ne$ nucleus. The heights of these levels above the ground-state are 9·86, 10·33 and probably 10·75 MeV., which is easily calculated with the help of the mass values[6].

Hitherto, resonances in the disintegration of neon by fast neutrons had been studied only by the method of Wilhelmy. In this method the pulse-size distribution is taken from an ionization chamber, which is exposed to a neutron source giving a continuous energy spectrum. The reaction products, caused by resonance neutrons, give rise to groups of pulses and therefore maxima in the distribution. As the energy and the number of resonance neutrons is not known, no definite conclusions can be drawn from groups observed with regard to energy-levels and cross-sections.

According to our results, maxima should be found in such experiments with neon at 1·8, 2·3 and 2·7 MeV., being caused by the process $^{20}_{10}Ne$ $(n\alpha)$ $^{17}_{8}O$,

with the residual $^{17}_{8}O$ nucleus in its ground-state. Gailer[7] gives maxima at 1·7, 2·4, 3·8, 4·8 and 5·3 MeV., though they are not very pronounced. The curve of Ortner and Protiwinsky[8] shows twelve peaks, including distinct ones at 1·73, 2·27 and 2·70 MeV. Zagor and Valente[9] find maxima at 0·85, 1·05 and 1·68 MeV. The work of Ortner and Protiwinsky, therefore, appears to be most consistent with the present work. On the other hand, no maximum at 2·7 MeV. is found by Gailer, and no peak at 2·3 MeV. appears in the curve of Zagor and Valente. Graves and Coon[5] give for the $(n\alpha)$ reaction in neon a cross-section of $0{\cdot}5 \times 10^{-26}$ cm.^{2} at 2·5 MeV. neutron energy.

I wish to thank Prof. D. Coster for his interest in the work, Mr. H. Nauta for assistance during the measurements, and the "Stichting voor Fundamenteel Onderzoek der Materie" for financial support.

C. P. SIKKEMA

Natuurkundig Laboratorium
der Rijks-Universiteit,
Westersingel 34, Groningen.
Feb. 10.

[1] Sikkema, C. P., *Nature*, **162**, 698 (1948).
[2] Argo, H. V., *Phys. Rev.*, **74**, 1293 (1948).
[3] Bennett, W. E., Mandeville, C. E., and Richards, H. T., *Phys. Rev.* **69**, 418 (1946).
[4] Livingston, M. S., and Bethe, H. A., *Rev. Mod. Phys.*, **9**, 245 (1937).
[5] Graves, E. R., and Coon, J. H., *Phys. Rev.*, **70**, 101 (1946).
[6] Jordan, E. B., and Bainbridge, K. T., *Phys. Rev.*, **51**, 385 (1937).
[7] Gailer, K., *Z. Phys.*, **110**, 605 (1938).
[8] Ortner, G., and Protiwinsky, G., Mitteilungen des Inst. f. Radiumf. Nr. 434 (1939); *Wien. Ber.*, IIa, **148**, 349 (1939); *Phys. Z.*, **44**, 116 (1943).
[9] Zagor, H. I., and Valente, F. A., *Phys. Rev.*, **67**, 133 (1945).

A Test of the Interpretation of X-Ray Patterns of Micelles

IN a recent communication[1] with the above title, Davies and Phillipoff have described X-ray diffraction experiments with multilayers of lead stearate on chrome-plated brass, which they interpret as deciding certain controversies regarding the micellar structure of soap solutions and the X-ray diffraction patterns from such solutions. Actually, it appears that their experiments have little bearing upon the soap solution results, because they differ in at least three important ways from the situation in real soap solutions.

In the first place, their multilayers, built upon the chrome plate from surface films, have dimensions parallel to the chrome surface far greater than the corresponding dimensions of lamellar micelles as commonly postulated in soap solutions. This will greatly modify their distribution of scattering power in reciprocal space as compared with that of a micelle if, as seems likely, the latter has widths which are comparable with their thicknesses.

Secondly, in these experiments the incident X-ray beam always made a small grazing angle with the chrome surface and thus was always nearly parallel with the multilayers. Consequently, the diffracted beam reveals only a small sample of the distribution of scattering power in reciprocal space. In soap solutions, on the other hand, the micelles are randomly oriented with respect to the beam, and the observed intensity at any point on the X-ray film is an unweighted average of the scattering power over the surface of a sphere in reciprocal space, provided the soap solution is sufficiently dilute so that the micelles are far enough apart to be spaced randomly and to scatter independently.

This last remark introduces the third source of error in the experiments. In most soap solution experiments described so far, the solutions are so concentrated that the distances between surfaces of adjacent micelles are of the order of the diameters of the micelles themselves. Due to anisotropy of both shape and surface-distribution of charge, neighbouring micelles certainly are partially ordered both in distribution of centres and in relative orientation. There will be diffraction effects arising from this partial ordering. The actual diffraction pattern from a soap solution is the result of a complex phenomenon in which the role of the distribution of scattering matter inside the micelle and that of the distribution of micelles about each other are so mixed up as to defy exact analysis except for very simple cases.

One of the latter is the model consisting of uniform spherical micelles distributed in space in a partially ordered way similar to that of molecules in an ordinary liquid. Corrin[2] has calculated the X-ray diffraction pattern for such a model. Using a square-topped distribution function to simplify the calculations, he showed that the scattering was similar to that from soap solutions. Using punched card methods[3] to ease the calculations, I have repeated his work with more reasonably shaped distribution functions and have obtained results identical within experimental error with the scattering curves from potassium laurate solutions, the agreement including not only the shape of the curve but also the position of the maximum. I do not propose this as a proof for spherical micelles, but merely to illustrate the point that there is literally an infinite number of models which will explain a given diffraction pattern, and one must utilize a wide variety of data to select the most plausible model.

Thus the conditions inside soap solutions are so different from those of the experiments described that the conclusions of Davies and Phillipoff can scarcely be accepted. This is particularly true with regard to their contention that Bragg spacings should be accepted at face value. It is the mixing-in of the intermicellar diffraction and the averaging over the surface of a sphere in reciprocal space, described above, of a diffuse pattern from a non-periodic structure, that vitiates the application of Bragg's law to patterns from soap micelles; and it is particularly these features of the problem that their experiment leaves out. On the other hand, the practice of multiplying Bragg spacings by the factor 1·23 is only slightly less naïve. From the above discussion it is clear that Bragg spacings corresponding to maxima in soap solution patterns, which although appearing fairly sharp to the eye are actually quite diffuse in comparison to the total scattering angle, usually have no direct significance as actual distances or constant ratios to distances in or between micelles.

EDWARD W. HUGHES
Gates and Crellin Laboratories of Chemistry,
California Institute of Technology,
Pasadena, California.

[1] Davies, J. T., and Phillipoff, W., *Nature*, **164**, 1087 (1949).
[2] Corrin, M. L., *J. Chem. Phys.*, **16**, 849 (1948).
[3] Shaffer, jun., P. A., Schomaker, V., and Pauling, L., *J. Chem. Phys.*, **14**, 659 (1946).

A DISCUSSION of the points raised by Dr. E. W. Hughes is postponed for inclusion in a full report of the results to be published elsewhere.—W. PHILIPPOFF.

Gamma-Rays from Thulium-170

In order to verify that the gamma-rays from thulium-170 reported[1], in addition to the well-established transition of ~ 83 keV., were not, in fact, *Bremsstrahlung*[2], the secondary electron spectrum from a source of 5–10-millicuries strength has been examined in the short-lens beta-ray spectrometer using high transmission (low resolving power).

Thin gold and both thick and thin lead radiators were used, and in each case a weak K photo-electron line from a gamma-ray of energy 198 ± 2 keV. was observed. Measurements were also made on the continuous spectrum of Compton electrons ejected from the brass capsule containing the active material. A group with an end-point corresponding to a gamma-ray energy of 360 ± 10 keV. can be identified with some certainty, and there is also a group of higher energy and much lower (¼) intensity. If this is a Compton electron group, its shape implies the presence of at least two gamma-rays, of which the harder has an energy of ~ 550 keV. (± 40). The other possibility is that the upper group is due to *Bremsstrahlung*.

P. J. Grant

Cavendish Laboratory,
Cambridge.
Feb. 28.

[1] Grant, P. J., and Richmond, R., *Proc. Phys. Soc.*, A, **62**, 573 (1949).
[2] Graham, R. L., and Tomlin, D. H., *Nature*, **164**, 278 (1949).

Sudden Commencements in Geomagnetism

From a recent study of geomagnetic 'sudden commencements' at seven magnetic observatories, Ferraro and Parkinson[1] suggested the possible dependence on magnetic longitude of the occurrence of what they termed "Type II" sudden commencements, that is, the type in which the increase in the horizontal force H is preceded by a smaller preliminary movement in the opposite direction.

This suggestion has been tested by an examination of sudden commencements recorded at the Lerwick Observatory (Shetland Is.) between April 1934 and December 1949. This examination yielded a total of 340 sudden commencements. Following Ferraro and Parkinson's classification, 65 of these 340 Lerwick sudden commencements were classified Type I (characterized by a sudden increase in H following a more or less quiet period), 162 were classified Type II, and 113 Type III (that is, sudden commencements of the 'inverted' type, characterized by a decrease in H). Thus the ratio of Type II to total number of sudden commencements found for Lerwick (magnetic longitude 88·6°) was 0·48. This value is very close to that suggested by Ferraro and Parkinson on the basis of magnetic longitude.

Detailed examination of the Lerwick sudden commencements has yielded other interesting features which are under investigation.

We are indebted to the Director, Meteorological Office, London, for permission to publish this note.

R. A. Watson
D. H. McIntosh

Meteorological Office,
Edinburgh.
April 25.

[1] *Nature*, **165**, 243 (1950).

Masses of Fundamental Particles

The following empirical relation

$$\left(\frac{M_1}{m}\right)^2\left(\frac{M_1}{m}-\frac{M_2}{m}\right)=\frac{2}{\alpha^2}=2\times 137^2$$

has been found, connecting the masses M_1 and M_2 of the fundamental particles and the electron mass m.

Substituting for M_2 the present value 1837·56 m for the mass of the neutral hydrogen atom, it is found that M_1 is 1839·08 m, in excellent agreement with the experimental neutron mass 1839·05 m. This simple relation between the neutron and hydrogen atom is consistent with Eddington's[1] concept of the neutron as a hydrogen atom in the 0-quantum state.

In the same way, substituting $M_2 = 216\,m$ for the mass of the μ-meson, it is found that $M_1 = 281\,m$, in good agreement with the present experimental value of 285 ± 5 m for the π-meson.

Assuming the existence of a neutrino of zero rest-mass, it is seen that $M_1 = 173\,m$; this value is in close agreement with Eddington's[1] value of 173·98 m for the meson mass. No derivation of this relation has yet been found.

G. Stephenson

Department of Physics,
Imperial College of Science and Technology,
London, S.W.7.
Feb. 22.

[1] Eddington, A. S., "Fundamental Theory" (Cambridge, 1948).

Mechanism of the Geiger Discharge

In the original theory of Townsend, the discharge phenomena in the Geiger counter are explained on the assumption of ionization by electrons (α ions per cm.) followed by an ionization by positive ions (β ions per cm.). Later this theory, especially as a consequence of the fact that ionization by positive ions requires a high energy, was modified in such a way that the secondary process was considered to consist of electrons liberated from the cathode by photons from the primary avalanche ($\theta\gamma g$ photo-electrons from one field electron per cm. path). Both theories give analogous mathematical expressions for the sparking equation and for the current amplification in the homogeneous field between plane surfaces. Thus it is impossible to decide between the two possibilities.

By the calculation of the avalanches in the axial-symmetrical field of the Geiger counter, it can be proved, however, that the observed values of the starting voltage V_A are best explained by assuming ionization by positive ions. The Geiger discharge, in contrast to the current idea of photo-electric multiplication, is thus explained as being started by a small primary electron avalanche, from which positive ions produce new ion-pairs in the immediate neighbourhood of the wire. Electrons from these new ion-pairs form secondary avalanches in which secondary positive ions are produced in a quantity which at the starting voltage is equal to the number of ions in the primary avalanche.

This assumption leads to the following sparking equation at V_A:

$$\int_{r_1}^{r_2}(M_r - 1)\beta dr = 1,$$

M_r being the factor of multiplication in the electron avalanche, r_i and r_c the radii of the central wire and the cylinder respectively. This equation can be shown to be valid with the observed values of α and β in hydrogen and nitrogen.

A similar expression for the photo-electric mechanism is not valid with the observed values of α and θ_{rg}. In this case the starting potentials would be expected to be at voltages equal to half the actual observed values.

Since the ionization by positive ions is confined to a narrow zone around the wire, the calculated time for development of the secondary avalanches will be of the order of 10^{-7} sec., even with the comparatively small mobilities of the positive ions. It can further be shown that many of the properties of the Geiger discharge hitherto unexplained can be easily accounted for by this interpretation of the discharge mechanism. The details of the investigation will shortly be published elsewhere.

The new explanation of the Geiger discharge will involve reconsideration in other gaseous discharges of the role of the positive ions for avalanche multiplication.

SVEN WERNER

Det fysiske Institut,
Aarhus Universitet,
Denmark.
Feb. 1.

The Scintillation of Stars

THE observational evidence provided in the letters which have appeared under this heading in *Nature* of April 29 and earlier suggests to a meteorologist that scintillation may be associated with waves at an interface between two currents of air. It is rather unlikely to be associated with turbulence because in a turbulent (that is, well-mixed) atmosphere the light from the star from one moment to another, passing, as it does, through thousands of random eddies, would be most unlikely to vary appreciably or in any systematic manner.

Waves at a discontinuity in the atmosphere, if traversed by the light, should, however, be capable of producing substantial and systematic optical differences. From the evidence of microbarograms, anemograms and cloud photographs, I estimated[1], a number of years ago, that such waves should not uncommonly have an amplitude of the order of up to 500–1,000 ft. at the interface, wave-length up to 10 miles or more, speed anything up to 40 ft. per sec., but probably usually lower. Such waves are most easily seen in the anemograms from a well-exposed station (for example, Bell Rock), where they are not obscured by surface turbulence effects. Though the waves can be seen from time to time in the records of individual stations, especially in the evening, it is seldom that the same fluctuations can be sufficiently related at a number of stations to enable the speed of propagation to be determined. The periods range from a minute or two up to an hour or more.

Quite recently a number of horizontal flights have been made by the Meteorological Research Flight, measuring temperature and frost point at intervals of about a mile (20 sec. flying time). In at least one case where a suitable discontinuity of wind and temperature existed, the measured temperatures and frost points appeared as wave-like oscillations consistent with waves of the dimensions mentioned earlier. It has to be kept in mind that usually, whenever there is a well-marked discontinuity in the atmosphere, the air below the discontinuity is characterized by saturation or near saturation, and very often a haze layer, while the air above is notably dry. The discontinuity of temperature may be of the order of 5°–7° F., so that waves of the dimensions mentioned might produce a sufficient optical effect; alternatively the periodic intervention of cloud or haze might be responsible. I have also examined and illustrated[2] the formation of cloud when the wave motion takes place under adiabatic conditions. The direction of travel of the waves is not usually, of course, the direction of the lower air current; it depends on the relative movement of the two currents.

A. H. R. GOLDIE

Meteorological Office,
Kingsway, London, W.C.2.
May 16.

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Magneto-Hydrodynamic Waves in a Plasma

AT low frequencies transverse waves can be propagated through a conducting liquid, situated in a magnetic field, as was first shown by H. Alfvén[1] and verified by S. Lundquist[2] in a laboratory experiment. The waves, as obtained by the reciprocal action between electric currents and motion of the liquid, were called magneto-hydrodynamic waves.

The theory was derived from Maxwell's equations:

$$\text{curl } \mathbf{H} = \frac{1}{c}\left(4\pi\mathbf{i} + \frac{\partial \mathbf{D}}{\partial t}\right) \tag{1}$$

$$\text{curl } \mathbf{E} = -\frac{1}{c}\cdot\frac{\partial \mathbf{B}}{\partial t}; \tag{2}$$

combined with

$$\mathbf{i} = \sigma\left(\mathbf{E} + \left[\frac{v}{c}\mathbf{B}\right]\right) \tag{3}$$

and

$$\rho\frac{d\mathbf{v}}{dt} = \left[\frac{\mathbf{i}}{c}\mathbf{B}\right] - \text{grad } p. \tag{4}$$

Since the liquid is incompressible, the equation of continuity can be written

$$\text{div } \mathbf{v} = 0. \tag{5}$$

A treatment of these equations shows that waves can be propagated along the lines of force of the applied magnetic field H_0 and that the phase velocity, for infinite conductivity, is

$$V = H_0/(4\pi\rho)^{1/2}, \tag{6}$$

where ρ is the mass density of the liquid.

The displacement current is negligible compared with the conduction current. The latter is capacitive, storing energy as kinetic energy, which consequently takes the same role as the electric energy in the vacuum wave.

It is interesting to study whether waves of this type can exist in an ionized gas, where (3) and (5) do not hold. In order to investigate this problem, we use Maxwell's equations (1) and (2). Ignoring collisions, the current is

$$\mathbf{i} = \sum_r n_r e_r \mathbf{v}_r, \tag{7}$$

where n_r is the number of particles, e_r the charge and $\mathbf{v}_r$ the directed velocity of the rth type of particle. The sum is to be extended over all types of particles.

The charged particles move under the action of electric and magnetic fields, and the equation of motion is

$$\frac{d\mathbf{v}}{dt} = \frac{e}{m}\left(\mathbf{E} + \frac{1}{c}\,[\mathbf{vB}]\right). \qquad (8)$$

The equations (7) and (8) are to be used instead of (3) and (4). Since the plasma is compressible, the restriction given by equation (5) drops out.

Assuming sufficiently low electron temperature, a discussion of the equations (1), (2), (7) and (8) shows that, well below the gyro-frequencies for the ions, magneto-hydrodynamic waves are possible, and that (6) still gives the phase velocity for waves propagated along the magnetic lines of force. This may seem somewhat surprising, because of the difference in the conductivity equations used in the liquid and in the plasma case. This difference is more formal than real. For infinite conductivity, (3) indicates that $\mathbf{E} + \frac{1}{c}\,[\mathbf{vB}]$ is zero in the liquid. For low frequencies (8) indicates the same for the plasma. This characteristic condition means that the magnetic flux through a surface moving with the liquid is independent of time. In both cases the magnetic lines of force will therefore move with the plasma. The compressibility is left as the real difference.

In a partly ionized medium without collisions, ρ in (6) means the density of the ionized part of the plasma. If collisions occur, the whole medium will take part in the motion below a certain frequency, and then ρ in (6) is, as for the liquid, the total density.

The magnetic field makes the medium anisotropic, and hence for each direction of the wave normal two plane waves are possible. For one of these the velocity of the medium is always perpendicular to the wave normal. Hence (5) is satisfied. This wave behaves similarly in the liquid and in the plasma. The energy flow is always along the magnetic lines of force. The phase velocity depends upon the direction of the wave normal.

For the other wave the velocity of the medium has a component in the direction of the wave normal. Then (5) is not satisfied, and consequently this wave does not behave similarly in the liquid and in the plasma. The phase velocity is independent of the direction of the wave normal for the plasma wave.

In the usual magneto-ionic theory, the motion of ions has always been neglected. Since the magneto-hydrodynamic waves are caused by the combined motion of all particles, or at least all charged particles in a neutral medium, these waves are not included in the theory discussed.

The component of the motion along the wave normal, in a medium with finite compressibility, will give a wave which is a transition between a transverse electromagnetic wave (or magneto-hydrodynamic one) and a longitudinal pressure wave, as is shown by N. Herlofson[3].

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E. Åström

Department of Electronics,
Royal Institute of Technology,
Stockholm 26.
March 22.

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Magneto-Hydrodynamic Waves in a Compressible Fluid Conductor

The theory of magneto-hydrodynamic waves in a conducting liquid has been studied by Alfvén[1] and his collaborators[2], and applied particularly to the theory of sunspots. Recently attempts have been made to apply similar ideas to account for the heating of the solar corona[3], and the generation of cosmic radiation[4].

The theory has only been developed for the case of an incompressible liquid, where the possible types of waves are restricted by kinematical conditions. To remove this limitation, the magneto-hydrodynamic motions should be studied in different kinds of compressible fluids in magnetic fields. The case of a collision-free, ionized gas has been studied by Åström[5], and a combination of sound waves and magneto-hydrodynamic waves will be described in the present note.

When a perfectly conducting fluid is immersed in a magnetic field $\mathbf{H}$, a velocity field $\mathbf{v}$ will be associated with an electric field $\mathbf{E} = \mathbf{H} \wedge \mathbf{v}/c$. If curl $\mathbf{E} \neq 0$, the electric field leads to a variable disturbance $\mathbf{h} = \text{curl}\ (\mathbf{r} \wedge \mathbf{H})$ in the magnetic field, where $\mathbf{r}$ is the displacement of the fluid elements. It is assumed that $\mathbf{h} \ll \mathbf{H}$. The magnetic disturbance $\mathbf{h}$ is associated with a current density $\mathbf{j} = \text{curlcurl}\ (\mathbf{r} \wedge \mathbf{H})c/4\pi$, which gives rise to a force density $\mathbf{j} \wedge \mathbf{H}/c$.

The equation of motion is found by adding the electromagnetic force and the force due to elastic compression, which gives

$$\frac{\partial^2 \mathbf{r}}{\partial t^2} = \text{curlcurl}\ (\mathbf{r} \wedge \mathbf{H}) \wedge \mathbf{H}/4\pi + U^2 \nabla\ \text{div}\ \mathbf{r}, \qquad (1)$$

where ρ is the density and U the velocity of sound.

We consider disturbances which are propagated as plane waves with a wave normal $\mathbf{n}$ at an angle φ with the homogeneous magnetic field $\mathbf{H}$. A discussion of eq. (1) shows that for each value of φ three modes of propagation are possible. In the important case when the magneto-hydrodynamic velocity $V = H/(4\pi\rho)^{1/2}$ is small compared with U, the first two modes are essentially magneto-hydrodynamic waves, and only one of them is disturbed by the compressibility of the fluid. The third wave is essentially a sound wave, disturbed by the electromagnetic forces.

In the first mode, $\mathbf{r}$ is perpendicular to $\mathbf{n}$ and $\mathbf{H}$, and is therefore directed along the phase planes. This wave is identical with the magneto-hydrodynamic wave known from incompressible liquids, and is propagated with a velocity $V \cos\varphi$.

In the second mode, $\mathbf{r}$, $\mathbf{n}$ and $\mathbf{H}$ are coplanar, and, if $V \ll U$, $\mathbf{r}$ is directed nearly along the phase planes, and the velocity is approximately equal to $V \cos\varphi$.

In the third mode, $\mathbf{r}$, $\mathbf{n}$ and $\mathbf{H}$ are coplanar, and, if $V \ll U$, $\mathbf{r}$ is nearly perpendicular to the phase planes, and the velocity of propagation is approximately $(U^2 + V^2 \sin^2\varphi)^{1/2}$.

When $V \ll U$, the first two modes show the strong anisotropy which is characteristic of magneto-hydrodynamic waves, whereas the third mode is nearly independent of the direction of propagation, as it would be for a sound wave. It is interesting to note that in the other limiting case, when $V \gg U$ and the pressure force is small, the third mode still exists as a compression wave with a velocity V independent of φ. From the present point of view this wave may be considered as a compression wave propagated in all directions not by means of pressure gradients, but by means of electromagnetic forces induced when

conducting matter is moving in the static magnetic field. A detailed study of the effect of finite conductivity on the different modes will be published elsewhere.

These waves may be of interest in solar physics, and lead to an estimate of the relative importance of the processes suggested by Schwarzschild[6] and by Alfvén[3] for heating the solar atmosphere.

I am indebted to Prof. H. Alfvén for stimulating discussions. This investigation has been supported by the Knut and Alice Wallenberg Foundation.

N. HERLOFSON

Department of Electronics,
Royal Institute of Technology,
Stockholm 26.
March 23.

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The Karyolytic Factor in the Serum of Rats Injected with Colchicine

RECENTLY, Euler *et al.*[1,2] have described a peculiar effect of certain normal, as well as sarcomatous, rat sera on the stainability of tumour cells. When smear preparations of mouse ascites carcinoma or rat Jensen sarcoma were incubated with the sera, a distinct loosening of the internal structure of the nuclei, demonstrated by May-Grünwald and Giemsa stains, and a total loss of Feulgen nucleal reaction, were observed. This effect was termed the 'karyolytic effect'. It was also noticed when smear preparations of rat liver pulp were incubated with some samples of normal and sarcomatous rat sera. Human and rabbit blood serum, however, did not show the effect. No relationship appeared to exist between the effect observed in the case of certain rat sera and any known physiological, pathological or dietetic factors. Recent attempts[3] to provoke 'karyolysis' by active immunization have not yet yielded any distinct positive results.

With the view of studying further the nature of the karyolytic factor, a method was sought of reproducing the effect by other means. The action of certain mitotic poisons on the karyolytic effect of rat serum was therefore examined. Very interesting and consistent results were obtained in the case of colchicine. Colchicine in doses of 100–600 μgm. were injected into rats weighing 150–300 gm., and the karyolytic effect of serum obtained from the blood collected after various intervals of time from injection was determined as before[1,2]. The smear preparations of liver were fixed with methanol, incubated with serum at 37° C. for 16–20 hr. and stained with Feulgen reagent.

There is a distinct loss of stainability by Feulgen nucleal stain when sera of rats injected with colchicine were incubated with smear preparations of liver obtained from the same rat (Fig. 1). The effect is more pronounced in the case of sera of blood collected twenty-four hours after the injection of colchicine, the effect increasing with increase in the concentration of colchicine injected. At lower concentrations of colchicine the nucleus stains very faintly after treatment with serum. In all these cases the cytoplasm is, however, much the same in control and serum-treated preparations. Complete removal of Feulgen-positive materials from the nuclei in smear preparations treated with serum of colchicine-injected rats was invariably observed when serum was obtained from the blood of rats sacrificed twenty-four hours after the injection of colchicine. The karyolytic effect of serum of colchicine-injected rats was also observed when liver preparations from normal rats (without colchicine injection) were used. The effect is therefore specific to serum.

Injection of acridine did not show such distinct and total loss of nucleal stain of practically all the cells coming in contact with the serum, as was observed in the case of colchicine. There was, however, a very small percentage of cells in which the nucleal stain was very weak. Injection of urethane and the sodium salt of camphoric acid did not show any such effect.

The enzymic nature of the karyolytic factor, its possible identity with some of the known enzyme systems present in serum and its physiological role are being investigated. Full details of the above investigation will be published elsewhere.

I wish to thank Prof. Hans von Euler for providing facilities for carrying out these investigations.

Note added in proof. Shortly after submitting this letter, it was found that the karyolytic factor occurs in the serum of normal guinea pigs.

K. V. GIRI

Vitamin Institute and
Institute for Research in Organic Chemistry,
University of Stockholm.
Feb. 20.

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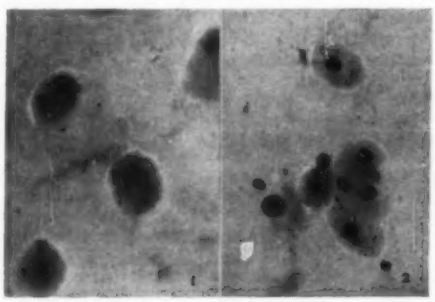

Fig. 1. Photomicrograph of rat-liver smear preparation treated with serum from the blood of rats injected with colchicine, showing distinct loss of stainability by Feulgen nucleal stain. (× 500)

Fig. 2. Photomicrograph of rat-liver smear preparation without serum treatment (control), showing the presence of intact nuclei. (× 500)

c-Mitotic Action of some Simple Gases

Levan and Östergren[1], and Gavaudan[2] have stressed the fact that the phenomena of mito-inhibition and of c-mitosis can be induced by, *inter alia*, a range of substances of diverse chemical constitution, alike only in this, that they belong to the class of inert narcotics. The first-named investigators observed a correlation between the threshold molar concentrations of such 'c-mitotic' substances and their water

solubility, the substances effective at the lowest concentrations being the least water-soluble. The existence of such a correlation is immediately understandable if it is postulated that many 'c-mitotic' substances act at thermodynamic concentrations or 'activities' of about the same order of magnitude, and when it is recalled that the thermodynamic activity at a particular concentration in solution of a sparingly soluble substance is given, very roughly, by the ratio of this concentration to the saturated concentration[3].

Guided by such conceptions, we have examined the effect on dividing cells in roots of *Allium cepa* of some gaseous narcotics—propane, nitrous oxide, argon, nitrogen, etc.—applied at sufficient pressure, that is, at sufficient concentration, to reach values of thermodynamic activity of the effective order of magnitude.

Sprouting bulbs of *Allium cepa* were suspended inside a thick-walled vessel for a period of 16 hr. and subjected to the action of simple gases at pressures in excess of atmospheric. The vessel contained a small quantity of water to keep the vapour moist; but the roots did not enter the water, and one atmosphere of air was allowed to remain in the vessel while the pressure was applied. The experiments were conducted at 25° C. After treatment, the root tips were fixed and permanent preparations made, using the Feulgen root-squash technique.

Microscopic examination showed that marked c-mitotic effects occurred. The threshold pressures required to induce full polyploidy lay at approximately the following values (column 2):

Gas	Approx. threshold pressure polyploidy (atmospheres)	Thermodynamic activity
Propane	1·5	0·19
Nitrous oxide	6	0·16
Nitrogen	80	0·06

The thermodynamic activities (fugacity ratios) of the effective concentrations given in column 3 were obtained by the method described in reference 4.

Characteristic c-pairs were produced at 40 atmospheres of methane, 75 atmospheres of argon and 200 atmospheres of hydrogen. In all cases the c-tumour effect described by Östergren was observed. Attempts to produce full polyploidy with these gases failed, because further increases in pressure merely produced mito-inhibition. It should be mentioned that Östergren found[5] that nitrous oxide, at ordinary pressure, induced c-mitosis in *Pisum sativum*, but not in *Allium cepa*, and suggested that the effect might be produced in the latter at higher pressures.

J. Ferguson
S. W. Hawkins
D. Doxey

Imperial Chemical Industries, Ltd.,
Alkali Division,
Research Department,
Northwich,
and
Jealott's Hill Research Station,
Bracknell, Berks.

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Purification of a Precursor of Nicotinic Acid from Wheat Bran

It has been observed that extracts from cereals give low values for nicotinic acid if analysed chemically without a previous digestion with alkali. After digestion with weak alkali, however, the apparent content of nicotinic acid is increased. The increase could be attributed either to the presence of some non-specific 'chromogen' or to a bound form of nicotinic acid present in cereals[1]. This finding has been confirmed by various workers[2–7], both by chemical and microbiological techniques. Krehl and Strong[6] produced evidence that the nicotinic acid was present in a bound form and called it the 'precursor' of nicotinic acid.

We have concentrated the precursor contained in wheat bran, and have obtained a preparation from which 27·8 mgm. nicotinic acid per gm. can be liberated. The purification involves thirteen stages, including chromatography and fractional precipitation with organic solvents. The precursor preparation so obtained is a brown powder readily soluble in water and in 70 per cent aqueous ethanol. In either of these solvents it has a *p*H value 4–5, at 1 per cent concentration. It readily yields free nicotinic acid when digested with 0·1 *N* sodium hydroxide for 10 min. at room temperature, but not when boiled for 30 min. with 0·1 *N* hydrochloric acid. Strong acid hydrolysis at 100° C. is needed to liberate nicotinic acid. The solution of this preparation has a blue fluorescence which changes to greenish-yellow at alkaline *p*H. The fluorescence is polarized, indicating that the fluorescent substance is either strongly attached to, or combined with, a large molecule[8]. It is not yet clear whether the fluorescence is connected with the nicotinic acid-containing substance or is due to impurities. All the usual protein reactions are positive. The paper chromatogram (for which we are indebted to Dr. S. M. Partridge of the Low Temperature Research Station, Cambridge, shows that several amino-acids are present in the preparation after hydrolysis with 5·5 *N* hydrochloric acid for 18 hr. Glucose was also detected after hydrolysis with 1 *N* sulphuric acid for 4 hr. No free amino-acids or sugars were present in the unhydrolysed preparation. Further purification will show which of these substances forms part of the precursor molecule.

The absorption curve of the precursor preparations showed two maxima, at 270 and 320 mμ. The intensity of the latter increased with the progress of purification.

The relative amounts of nicotinic acid found by us in various preparations of the precursor at different stages of concentration are shown in the accompanying table. For comparison, the data which Krehl and Strong[6] obtained with their preparations are also listed in the table. Microbiological assays

Nicotinic Acid Content (mgm./gm.) of Precursor Preparations at Various Stages of Purification

	Chemical	Microbiological		Krehl and Strong*	
	Digested	Undigested	Digested	Undigested	Digested
Wheat bran	0·2	0·02	0·2	0·204*	0·250*
Ppt. after stage IX	10·6	1·3	9·8	—	—
Ppt. after stage XII	20·8	1·9	18·6	—	—
Final ppt.	27·8	4·9	24·6	0·12*	1·65*

* Estimated microbiologically on their own preparations by Krehl and Strong (ref. 6).

using *L. casei* and a new nicotinic acid-free medium[9] show that the precursor is only fully active after digestion with weak sodium hydroxide or strong acid. The values given in the table suggest that all, or almost all, the nicotinic acid in wheat bran is present in the form of the precursor.

The precursor preparation does not give a positive test for N′-methyl-nicotinamide[10] or for the presence of alkyl-pyridinium substances[11], suggesting that the ring nitrogen carries no substituent. On the other hand, it forms an additive compound with cyanogen bromide, indicating a trivalent nitrogen in the pyridine ring. Furthermore, free nicotinic acid and not its amide is liberated on treatment with alkali[12]. It seems likely, therefore, that, in the precursor molecule, nicotinic acid is bound to a residual substance through its carboxylic group.

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D. K. Chaudhuri
E. Kodicek

Dunn Nutritional Laboratory,
University of Cambridge and
Medical Research Council. Feb. 17.

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A Technique for the Selection of Red Clover Seedlings Resistant to the Clover Rot Fungus, *Sclerotinia trifoliorum* Eriksson

During the course of work on the breeding of red clover resistant to clover rot, it was found necessary to devise a method of artificial inoculation which would act as a preliminary 'sieve' in the selection of resistant types for strain-building. The method described enables much larger populations to be handled than would be possible by any method involving mature plants.

Owing to the fact that *Sclerotinia trifoliorum* produces no accessory spores which could be utilized in suspension as an inoculum, a mycelial technique has been devised. Erlenmeyer flasks of moist sterilized bran are inoculated with mycelium from young, actively growing, potato-dextrose agar cultures of the fungus. After two weeks growth, when the latter has permeated completely through the bran, the contents are removed to shallow dishes, dried in an air oven at 30° C. for 48 hours, and powdered in a mortar. The prepared inoculum may be stored in a refrigerator set at 3°–4° C. for considerable periods without loss of viability.

Three-inch earthenware pots are sown, each with fifty red clover seeds, and the material watered from below by means of Knop's solution, which ensures healthy growth up to the time of inoculation. At the first trifoliate-leaf stage, the seedlings are dusted with the inoculum sprinkled from a sugar sifter, and covered with a Copenhagen jar to ensure conditions of adequate humidity. The attack usually commences about the third day, and spreads rapidly, until at the end of a week all but a few seedlings have been completely killed. The survival-rate under these conditions averages one per thousand seedlings inoculated, and these survivors are transferred to larger pots where they are brought on to maturity for further testing. No evidence is as yet available on the capacity of mature plants developed from these seedlings to resist infection.

Although the technique has been used only in connexion with work on *Sclerotinia trifoliorum*, it is conceivable that, with a few modifications, it could be used for other work on breeding for disease resistance, especially where resistance within a population is so rare as to necessitate the handling of large numbers of plants.

A. J. H. Carr
Welsh Plant Breeding Station,
Agricultural Research Building,
Penglais, Aberystwyth.

D. L. G. Davies
National Advisory Agricultural Service,
(Wales),
Trawscoed, Aberystwyth. April 13.

Protozoan Hyperparasitism of *Heterakis gallinæ*

Since Graybill and Smith's discovery[1] of the transmission of *Histomonas meleagridis*, the pathogenic protozoon of enterohepatitis (blackhead) of fowl, by the embryonated egg of the nematode *Heterakis gallinæ*, a good deal of attention has been given to the hyperparasitism of this nematode. Innumerable experiments have shown that feeding embryonated *Heterakis* eggs to susceptible birds almost invariably results in a fatal infection of *Histomonas*; but all attempts to demonstrate the actual organism in the egg have proved futile.

In the hope of elucidating the nematode cycle of *Histomonas*; female worms, recovered from turkeys dying of blackhead, were examined in sections stained by the Giemsa–Colophonium technique of Shortt and Cooper[2]. Of some hundred worms examined in this manner, only one gave evidence of

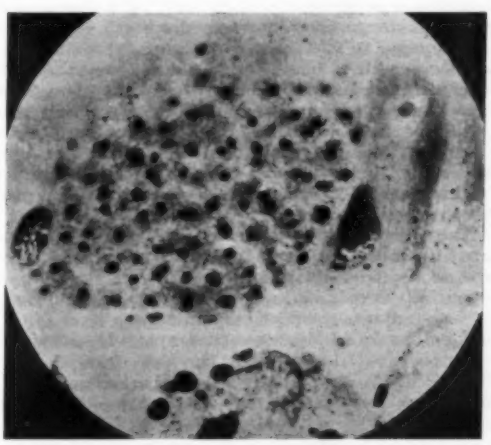

Fig. 1. Gut epithelial cells with included parasites

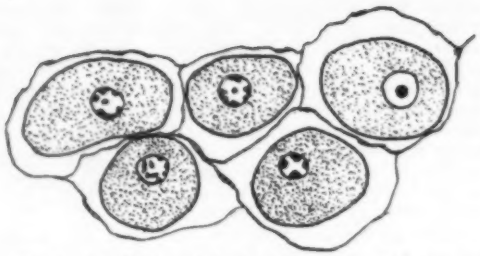

Fig. 2. Individual amœbulæ showing various nuclear stages

protozoan infection, and this occurred in two adjacent cells of the gut epithelium. The host cells (Fig. 1) were enlarged to 75 μ × 45 μ and their cytoplasm was for the most part destroyed. The nuclei of the cells were displaced to the periphery. The effect resembled a sac filled with amœbulæ between which were strands of material probably derived from the host-cell cytoplasm. These intracellular parasites give the appearance of having undergone schizogonic development. Each amœbula (Fig. 2) is more or less spherical in shape and measures 4·5–5 μ in diameter; the nucleus measures approximately 1·8 μ; the cytoplasm stains a pale blue and appears finely granular. There are some 130 such forms in the infected host cells. The nucleus of the amœbula has six to eight chromatin dots scattered through its substance or arranged about its periphery. One nucleus had the chromatin material gathered into one central mass forming a karyosome-like body.

It would be impossible to fix the true taxonomic status of this parasite until further stages in its life-history are elucidated, but its appearance would suggest a schizogonic development of a protozoon. Kudo[3] has described a microsporidian, *Thelohania reniformis*, in the intestinal epithelium of a parasitic nematode, *Protospiura muris*, of the house mouse; but, on careful consideration, the parasite described would appear to have little affinity with this microsporidian.

Reviewing hyperparasitism of helminths, Dolfus[4] describes *Urosporidium* infection of trematodes, again in the intestinal epithelium. The heterakid parasite shows some similarity to the pansporoblast stage of the *Haplosporidia*.

Histomonas has been described only once, by Tyzzer[5], as a parasite of *Heterakis*; this was in the gut epithelium as an intracellular form similar in morphology to the tissue-invading type, that is, amœboid with a vesicular nucleus containing six to eight granules. *Histomonas* does have the power of very rapid division, as anyone who has ever seen the tremendous number of 'invading-dividing' forms can testify, but the most one could say is that the possibility cannot be ruled out that the rapid division of this parasite in epithelial cells of the gut might give rise to forms such as are described here.

The object of this report is to describe a stage of what is probably a new parasite of *Heterakis gallinæ*, and to consider its possible taxonomic standing.

ROBERT S. DESOWITZ
Department of Parasitology,
London School of Hygiene and Tropical Medicine,
London, W.C.1.

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Aphid Migration and the Spread of Plant Viruses

RECENT work on the spread of potato virus diseases has indicated that the activity of the aphids in a crop is far more important than their numbers, and has turned attention away from the apterous aphids, comprising the bulk of the observed infestation, to the winged migrants[1]. Many workers have, however, assumed that the migrant aphids sense and make their way toward their specific host plants from a distance, and this has had an important influence on ideas about virus spread.

Like Heinze[2] and Broadbent[3], we have failed to find any evidence, in a variety of field and laboratory observations, that aphids are attracted to their hosts in this way. In 1947, autumn migrants of the peach-potato aphid, *Myzus persicæ* (Sulzer), were caught alighting quite indiscriminately on their specific winter host, peach, and on another tree, spindle, on which they do not over-winter. Thus the aphids exercised their selection between suitable and unsuitable hosts mainly after alighting on them. Most flew off again from the spindle, but not before many had fed on it for varying periods. Moreover, most of the aphids that landed on their appropriate host, peach, also flew off again sooner or later. It was obvious, from the far greater accumulation of peach aphids on the peach than on the spindle, that a smaller proportion of alighters must have flown off again from the peach than from the spindle; but the difference was barely detectable in collections of arriving and departing aphids. A small difference would have been quite sufficient to produce the spectacularly heavier infestation on the peach, given the large numbers of alighters involved. They were estimated as reaching tens of thousands per day on one four-foot tree.

These findings are not very surprising, because flying aphids cannot make any headway against winds as gentle as 1½ m.p.h. Even if they could sense the direction of a distant host plant, they could make little use of the information in practice. With gross wastage of individuals allowed for, the unwillingness of the migrants to remain on the first suitable host they meet can become a positive advantage for the species, guarding it against the risks of having 'all its eggs in one basket'. The fact that migrants take off again even from suitable hosts emphasizes the *active* nature of the dispersal flights of aphids, although these are often cited as the classic example of 'passive' migration. At the same time, the individual host plant, whether isolated or in a crop, must be regarded as the cause of little more than a local eddy in a vast, blind flow of migrants, not as the terminus of purposeful flights.

Thus it cannot be assumed that winged migrants do not visit and feed on plants they do not colonize. This was what Doncaster and Gregory[1], for example, assumed when they attributed the summer spread of potato viruses to the apterous aphids wandering in the crop, rather than to the winged migrants, on the grounds that the latter do not colonize potatoes at this time. That species of aphids which do not colonize a crop might contribute something to the spread of viruses within it has been pointed out by Broadbent[4]. The behaviour of the aphids suggests that they could, in theory, do more, and serve as virtually the *sole* vector for a crop they do not colonize. An actual case of this kind has been reported recently, namely, *Myzus persicæ* acting as the vector of cantaloupe

mosaic disease in California[5]. A more commonplace and apparently similar case to which Dr. R. Markham has directed my attention is that of tomato 'fern-leaf' disease, which may occur in a high percentage of plants without any aphid colonies.

It follows that the key considerations affecting the virus-spreading efficiency of a given aphid species are its ability to transmit the virus, and the abundance and activity of its winged forms, rather than its potentialities as a direct pest of the crop. Now *Myzus persicæ* seems to be an outstandingly restless aphid compared with, for example, *Aphis rhamni* Fonsc. and *Aphis fabæ* Scop., judging by the relative frequency with which their nymphs are found abandoned by the winged mothers. If we exclude *Myzus persicæ*, and assume that most other aphids are considerably less inclined than it to fly away again after alighting on a suitable plant, then it seems that the aphids and plants best suited to one another would not form the best system for virus spread, especially if the aphids can pick up and hand on the virus in short feeding periods. Among the winged aphids available and capable of transmitting the virus, those species also capable of becoming serious pests would be at some disadvantage, as virus-spreaders, compared with species less well adapted to the given plants. Those kinds or conditions of plants which were more susceptible to colonization by virus-transmitting aphids would have some advantage, in resisting virus spread, over plants more resistant to colonization. These points may be worth keeping in mind not only when seeking the insect vectors of plant virus diseases, but also when seeking to control the diseases by cultural or plant-breeding methods.

I owe much to Mr. F. C. Bawden, Dr. L. Broadbent and Dr. V. B. Wigglesworth for criticisms of this letter in draft.

J. S. Kennedy

Agricultural Research Council
Unit of Insect Physiology,
Zoological Laboratory,
Cambridge.
Feb. 22.

[1] Doncaster, J. P., and Gregory, P. H., "The Spread of Virus Diseases in the Potato Crop" (London, 1947).
[2] Heinze, K., *Nachr. Biol. Zent. Braunschweig*, **1**, 3 (1949).
[3] Broadbent, L., *Ann. App. Biol.*, **36**, 334 (1949).
[4] Broadbent, L., *Ann. App. Biol.*, **35**, 379 (1948).
[5] Dickson, R. C., Swift, J. E., Anderson, L. D., and Middleton, J. T. *J. Econ. Ent.*, **42**, 770 (1949).

Recent Irish Records of Rare Fish

With reference to Mr. Colin Matheson's records of rare marine fish in British waters[1], it is worth recording that on October 11, 1949, a globe-fish (*Lagocephalus lagocephalus* L.) was found dead at the pier, Dingle, County Kerry. Two days previously it had been seen apparently swimming aimlessly around. In the meantime it had received several shot wounds. It is interesting to note that, according to the *Fishing News*[2], another specimen of this species was found off Mousehole Harbour in Cornwall, it having been seen in similar circumstances to the Dingle specimen a few days earlier.

Two specimens of the file or trigger-fish (*Balistes capriscus* Gmelin) were taken on October 31, 1947, five miles south of Dingle Harbour and on November 18, 1948, five miles south-east of the same place. Only two previous Irish specimens have been recorded. On March 30, 1948, a boar-fish (*Capros aper* Lacep.) was captured in Dingle Bay. This species has been recorded on only a few occasions from Irish waters.

A specimen of an even rarer species *Luvarus imperialis* Rafinesque was taken off Castletownsend, County Cork, on July 27, 1948. It was identified by several people; but unfortunately it was not preserved. A long-finned tunny (*Orcynus germo* Day) was taken near Brandon Creek, west of Dingle, on September 16, 1947, and although the species is common in the Mediterranean and more southerly waters of the Atlantic, it has only been recorded three times from Irish waters. Ray's bream (*Brama raii* Bloch), which has been recorded a few times previously from the Irish coast, was represented by two specimens taken at Castletownsend and Dingle respectively, on October 25, 1948, and November 15, 1948.

Finally, the sting ray (*Trygon pastinaca* L.), which has been recorded only a few times in Irish waters, was noted twice, on November 19, 1947, and February 16, 1948, again in Dingle Bay. Most of these specimens of rare Irish fish have been deposited in the Natural History Section of the National Museum, Dublin.

Arthur E. J. Went

Fisheries Branch,
Department of Agriculture,
Dublin.
Feb. 20.

[1] *Nature*, **165**, 193 (1950).
[2] *Fishing News*, Nov. 6, 1949.

A Little-known Tyroglyphoid Mite, *Histiostoma polypori* (Oud.), and its Association with the Earwig, *Forficula auricularia* Linn.

Michael[1] described only four species of the genus *Histiostoma* from the British Isles. Of these, *H. pulchrum* Kramer and *H. spiniferum* Michael have been renamed as *Sellea pulchrum* and *Wichmannia spiniferum* respectively[2]. I found the hypopi of *Histiostoma polypori* (Oud.) on the body of the common European earwig, *Forficula auricularia* Linn., in Edinburgh, and all its stages were reared in the laboratory of the Department of Zoology there. Hence *H. polypori* is the third valid species of the genus *Histiostoma* to be recorded from the British Isles. Oudemans first described this species in 1914 as *Anoetus polypori* and gave an insufficient description based only on the hypopus.

The hypopus stage of Tyroglyphoid mites has been regarded by various authors (like Vitzthum[3] and Solomon[4]) as a migratory phase the association of which with the vector insect was only temporary. In the case of *H. polypori*, the infection of hypopi on the body of the earwig was found to be very heavy in the region of the head and the mouth-parts, and mere numbers in heavy infestations interfered with the feeding and locomotion of the host. The hypopi remained attached to the nymphs and adults of the earwig until the hosts died or until a favourable situation was encountered, when they dropped off and moulted into deutonymphs to form a flourishing colony. Hypopi clinging to nymphs of *F. auricularia* migrated to the new cuticle of the

moulting earwig and so remained attached to the host until it attained the adult condition and eventually died; its decomposing remains then furnished food for the different stages of the mite.

A fuller account of the taxonomy, life-history and feeding of the mite and its association with *F. auricularia* will be published elsewhere.

I am indebted to Mrs. A. M. Hughes, of the London School of Medicine for Women, for her kind help in the determination of the mite.

B. K. Behura

Department of Zoology,
University of Edinburgh.

[1] Michael, A. D., "British Tyroglyphidæ", **1** (1901).
[2] Oudemans, A. C., *Ber. Ned. Ent. Ver.*, **4**, 72 (1914); *Ent. Ber., 's Gravenhage*, **7** (167), 449 (1929).
[3] Vitzthum, H. G., *Arch. Hydrobiol., Stuttgart*, Suppl. 9, 117 (1932).
[4] Solomon, M. E., "Tyroglyphid Mites in Stored Products", I, Survey of Published Information. (London: H.M. Stationery Office, 1946.)

South African Stone Age Terminology

The correspondence between Mr. B. D. Malan and Mr. M. C. Burkitt on this subject[1] calls for comment.

The crux of the matter lies in the sentence (par. 3 of Mr. Malan's letter): "it would have been difficult to justify the coining of a new name for the South African discoveries". There are two implications here: (i) that there was a recognizable difference between the Ladybrand assemblage and the type Magosian of Kenya, but insufficient to justify a new local term; (ii) that no South African term exists covering the Middle to Later Stone Age transition. The first implication cannot be judged as no full account of the excavations is yet published. The second is wholly misleading, as the term Howieson's Poort (Howiesonian) from the type-site excavated and published by Stapleton and Hewitt[2] has been in generally accepted use since 1928[3].

Burkitt himself discussed the apparent mixed origin of the Howiesonian material in a footnote to Stapleton and Hewitt's paper (*op. cit.*, p. 587).

My attention has been directed to the fact that Mr. Neville Jones described an analogous assemblage from Sawmills in 1926, and that in 1947 he renounced any claims to priority in favour of 'Magosian'. The position is rendered the more difficult as in 1947 the term Howiesonian had been in accepted usage for nineteen years. It would seem reasonable for Mr. Malan to turn first to local terminology for his comparisons, and only then to turn to Kenya (two thousand miles away) for an alternative. It is clear from my knowledge of the facts that the Magosian and Howiesonian are not identical if judged from type-sites, but that the cultural variations intervening have led to the terms being used as synonyms.

Leaving aside Mr. Neville Jones's prior (but renounced) claim for the moment, usage has made 'Howiesonian' the acceptable term for the southern region, while 'Magosian' more clearly fits the northern and equatorial region.

While those of us (Neville Jones and myself) who first analysed our regional prehistoric cultures and gave them names have been (probably wisely) eliminated from any further say in terminology, the claims for regional terms (where these terms have been accepted by usage) still remain until sufficient identity of assemblages can be established.

Without wishing to add further claims to any priority, may I add that, on re-analysis, the uppermost deposit recognized at Montagu Cave can now be assessed as of Howiesonian type. It was originally regarded as a large variant of the normally microlithic Wilton when I described the work in the cave in 1924 (published in 1929 by the South African Museum).

A. J. H. Goodwin

University of Cape Town,
Rondebosch.
April 20.

[1] *Nature*, **165**, 204 (1950).
[2] *S. Afric. J. Sci.*, **24** (1927) and **25** (1928)
[3] See Goodwin, *S. Afric. J. Sci.*, **25** (1928), and *Ann. S. Afric. Mus.*, **27** (1929).

I wish to give wholehearted support to Mr. B. D. Malan in his use of the term 'Magosian' with the qualifying regional prefix 'South African' for the industry to which he has applied it. Industries of Magosian culture are now known from Abyssinia and Somaliland in the north, through Kenya, Uganda, and Tanganyika, to the two Rhodesias and then to South Africa.

I have examined material of all these industries and I can allay Mr. Burkitt's fears that they may not, in fact, belong to one and the same culture. They undeniably do so, in exactly the same way that industries of the great Chelles–Acheul culture do over an even wider area.

Confusion, as Mr. Burkitt so rightly says, comes in when prehistorians wrongly use *cultural terms* like Clacton and Levallois for *techniques* which have a wide distribution in time and space, and we in Africa have now set our face sternly against confusing cultural terms and words describing techniques.

I agree with Mr. Burkitt in doubting the validity of using simple typology by itself to determine the culture to which any industry belongs. But if an industry is found to have in its total assemblage all the essential cultural elements of a similar industry of a known culture elsewhere, and more particularly if a series of sites with similar industries link these two together, then there is every justification for regarding the industries as belonging to the same culture, rather than invent a new name.

L. S. B. Leakey

Coryndon Museum,
Nairobi. May 3.

I am glad my letter has proved of interest, and I am content to have one of my old pupils on my side, even if the other, Dr. Leakey, opposes. There is one comparison he makes which I do feel calls for comment. It is true that the Chelleo-Acheulean (Stellenbosch) industries, whether in Western Europe, East or South Africa, closely resemble one another; but that is not why I suggest a similarity of culture. The point is that the evolution of these industries in the various regions is well-nigh identical, although the environment and materials used were different. The fact that an industry in Somaliland resembles one in Uganda and another in South Africa is not quite enough to satisfy me of the identity of the culture throughout the continent. I am not convinced that a single culture ever occupied such wide areas in Africa in later prehistoric times. I may be wrong; but I still feel that it is safer for the present to use regional names for the various cultures, and to await a time in the future when further information will enable surer correlations to be made.

M. C. Burkitt

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Saturday, June 24

AMATEUR ENTOMOLOGISTS' SOCIETY (at Buckingham Gate Central Schools, Wilfred Street, London, S.W.1).—Exhibition of Living and Preserved Insects; Mr. E. E. Syms: "Study of Living Insects"; Mr. G. B. Collins: "Orthoptera".

Monday, June 26

MEDICAL RESEARCH COUNCIL (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Prof. A. C. Burton (University of Western Ontario): "Transfer of Heat and of Vapour through Clothing".*

Tuesday, June 27

UNIVERSITY OF LONDON (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Prof. C. J. Watson (Minnesota): "Some Recent Studies of Porphyrin Metabolism and Porphyria" (Special University Lecture).*

Tuesday, June 27—Thursday, June 29

INSTITUTION OF NAVAL ARCHITECTS (joint meeting with the INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND AND THE NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS, at Newcastle).—Joint Summer Meeting.

Wednesday, June 28

MEDICAL RESEARCH COUNCIL (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Prof. A. C. Burton (University of Western Ontario): "The Science of Field Testing".*

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, London, S.W.7), at 6 p.m.—Prof. Tor Bergeron (Uppsala): "Tropical Hurricanes".

Thursday, June 29

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Prof. J. Z. Young, F.R.S.: "Growth and Plasticity in the Nervous System" (Ferrier Lecture).

Thursday, June 29—Saturday, July 1

INSTITUTE OF PHYSICS, MANCHESTER AND DISTRICT BRANCH (joint meeting with the BRITISH RHEOLOGISTS' CLUB, in the Physics Department, The University, Manchester), at 2 p.m.—Conference on "The Physics of Lubrication".

Friday, June 30

INSTITUTE OF RURAL LIFE AT HOME AND OVERSEAS (in Room 301, The Church House, Great Smith Street, London, S.W.1), at 2.30 p.m.—Dr. Raymond W. Miller: "The Influence of Rural Co-operatives in the Southern States of the U.S.A.".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

CHAIR OF MATHEMATICS—The Registrar, University College, Cathays Park, Cardiff (July 1).

REGISTRAR IN THE DEPARTMENT OF BIOCHEMISTRY, United Oxford Hospitals—The Administrator, Radcliffe Infirmary, Oxford (July 1).

SENIOR ASSISTANT IN BIOLOGY, a LECTURER IN PHYSICS, and a LECTURER IN PHYSIOLOGY—The Clerk to the Governors, South-East Essex Technical College and School of Art, Longbridge Road, Dagenham, Essex (July 1).

VETERINARY RESEARCH OFFICERS in the Department of Agriculture and Lands, Southern Rhodesia—The Secretary to the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (July 1).

ASSISTANT POMOLOGIST at the Long Ashton Research Station—The Secretary and Registrar, The University, Bristol (July 3).

ANALYTICAL CHEMISTS (Principal Scientific Officer or Senior Scientific Officer grade) at the Atomic Energy Research Establishment, Harwell, to take charge of a consulting and development section of the Analytical Chemistry Group—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No. 3128TC (July 6).

ASSISTANT LECTURER IN BACTERIOLOGY—The Registrar, The University, Manchester 13 (July 7).

JUNIOR LECTURER (with an honours degree in chemistry or biochemistry) IN THE DEPARTMENT OF CHEMICAL PATHOLOGY—The Dean, Guy's Hospital Medical School, London Bridge, London, S.E.1 (July 7).

ASSISTANT LECTURER (with honours degree in psychology, and special interest in social psychology) IN THE DEPARTMENT OF PSYCHOLOGY—The Registrar, The University, Liverpool (July 8).

LECTURER or ASSISTANT LECTURER IN THE DEPARTMENT OF ELECTRICAL ENGINEERING (Electronics)—The Registrar, The University, Liverpool (July 8).

PATENT OFFICERS (temporary) and SENIOR PATENT OFFICERS (temporary) in the Patents Branch of the Ministry of Supply—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.346/50A (July 8).

PRINCIPAL SCIENTIFIC OFFICER (with good honours degree in electrical or mechanical engineering or equivalent qualification and at least 7 years experience in design and development of small electrical and mechanical devices) at a Ministry of Supply Research and Development Establishment in the South Midlands—The Ministry of Labour and National Service, Scientific and Technical Register (K), York House, Kingsway, London, W.C.2, quoting D.160/50A (July 8).

TECHNICAL OFFICER (temporary) (with a professional qualification or equivalent in Electrical Engineering, preferably with administrative or executive experience) in the Technical and Scientific Register—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting D.154/50A (July 8).

LECTURER or ASSISTANT LECTURER IN PHYSICAL CHEMISTRY—The Registrar, Trinity College, Dublin (July 14).

LECTURER IN CHEMISTRY in the United College, St. Andrews—The Secretary, The University, St. Andrews (July 15).

SENIOR RESEARCH OFFICER (Wet Processing) (Ref. No. 2889), to carry out and direct research on scouring, dyeing and finishing, a SENIOR RESEARCH OFFICER (Dry Processing) (Ref. No. 2890), to carry out and direct research on carding, spinning and weaving, a SENIOR RESEARCH OFFICER (Felting) (Ref. No. 2891), to carry out and direct research on the felting and milling of wool with special reference to problems of the felt industry, at the Wool Textile Research Laboratory, Geelong—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (July 15).

LECTURER or ASSISTANT LECTURER IN CHEMISTRY at the University College of the West Indies—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (July 22).

LECTURER or ASSISTANT LECTURER IN ORGANIC CHEMISTRY at the University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (July 22).

CHAIR OF SOCIAL ANTHROPOLOGY at the University of Cape Town—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (July 31).

CHALLIS CHAIR OF CIVIL ENGINEERING at the University of Sydney—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Sydney, July 31).

CHARLES BROTHERTON SCHOLARSHIP tenable in the Department of Coal Gas and Fuel Industries with Metallurgy—The Registrar, The University, Leeds 2 (July 31).

CORBET WOODALL SCHOLARSHIP for a course of study in Gas Engineering at the University in preparation for a responsible position as a gas engineer—The Registrar, The University, Leeds 2 (July 31).

LECTURER IN PHYSICS at the University of the Witwatersrand, Johannesburg—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (July 31).

LECTURER IN STRUCTURAL GEOLOGY in the United College, St. Andrews—The Secretary, The University, St. Andrews (July 31).

READER or LECTURER IN THE HISTORY AND PHILOSOPHY OF SCIENTIFIC RESEARCH—The Secretary, The University, Aberdeen (July 31).

PROFESSOR OF PSYCHIATRY in the University of Sydney and DIRECTOR OF PSYCHIATRIC CLINICAL SERVICES in the State Mental Hospitals—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Sydney, August 31).

BURSARIES (3) for research in Physical Chemistry at the Imperial College of Science and Technology—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1.

BURSARY for research in Refractories Technology, tenable in the Department of Chemical Engineering and Applied Chemistry of the Imperial College of Science and Technology—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1.

DIVISIONAL CHIEF ANALYST (with honours degree in chemistry, or equivalent, thorough experience in general analytical chemistry and conversant with modern analytical techniques), and ANALYTICAL CHEMISTS, in the Scientific Department of the North-Eastern Division—The Divisional Chief Scientist, National Coal Board, Roundwood Colliery Offices, Parkgate, Rotherham.

ENTOMOLOGISTS (2) and an INSPECTOR, PLANT PROTECTION, in the Research Division of the Ministry of Agriculture, Sudan Government—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Agricultural Entomologist' or 'Plant Protection' as appropriate.

HEALTH PHYSICS AND SAFETY ASSISTANT GROUP MANAGER (with honours degree in physics, or associateship of the Institute of Physics) by the Division of Atomic Energy (Production), Windscale Works, Sellafield, Cumberland, to be responsible to the Group Manager for the measurement and control of radiation, including personnel monitoring and local and environmental surveys—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

INDUSTRIAL CHEMIST (with honours degree in chemistry or associateship of the R.I.C., and at least 5 years in the heavy chemical industry), to arrange for the purchase of chemical reagents and to provide the necessary assistance and guidance for industrial firms engaged in the erection and extension of large chemical plants—The Ministry of Supply, Division of Atomic Energy (Production), Risley, near Warrington, Lancs.

MICRO-ANALYST, and an ASSISTANT MICRO-ANALYST, in the Department of Chemistry—The Bursar, The University, Sheffield 10.

PHYSICAL CHEMIST with good knowledge of surface chemistry, for work on the physico-chemical relationships between pigments and organic media in surface coating materials, an ORGANIC CHEMIST with 2 years research experience, for work on polymerization reactions of unsaturated fatty acid derivatives, and 'FIRST APPOINTMENT' GRADUATES who feel they would be interested in the work of the Station—The Director, Paint Research Station, Waldegrave Road, Teddington, Middx.

SENIOR LECTURER IN PHYSICS, a LECTURER IN PHYSICS to Degree standard, a LECTURER IN MATHEMATICS to Degree standard, a LECTURER IN GEOLOGY to Degree standard, and a LECTURER IN CHEMISTRY to Degree standard (with qualifications in physical chemistry)—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S.W.3.

UNIVERSITY GRADUATES (with qualifications in Mathematics, Science (Physics, Chemistry or Metallurgy) or Engineering) for Commissions in the Instructor Branch, Royal Navy—The Director (P), Education Department, Admiralty, London, S.W.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Ministry of Agriculture and Fisheries. Fishery Investigations Series 2, Vol. 17, No. 2: The Experiments on the Cornish Pilchard Fishery in 1947–48. By Dr. William C. Hodgson and Ian D. Richardson. Pp. 21. (London: H.M. Stationery Office, 1949.) 2*s*. net. [194

Some Relations between Chemistry and Biology: being the Fifty-first Robert Boyle Lecture delivered before the Oxford University Scientific Club on November 15, 1949. By Sir C. N. Hinshelwood. Pp. 14. (Oxford: Blackwell Scientific Publications, Ltd., 1950.) 2*s*. net. [194

Operational Research Quarterly. Vol. 1, No. 1, March. Pp. 16. (London: Operational Research Club, 1950.) 3*s*.; annual subscription, 10*s*. [194

Shaw Society. Tract No. 1: Creative Evolution. Definitions by Henry Charles Duffin, revised by Shaw. Pp. 8. (London: Shaw Society, 1950.) 6*d*. [194

Reports of the Council and Auditors of the Zoological Society of London for the Year 1949. Pp. 40. (London: Zoological Society of London, 1950.) [194

British Electrical and Allied Manufacturers' Association. Thirty-ninth Annual Report, 1949–1950. Pp. 47. (London: British Electrical and Allied Manufacturers' Association, 1950.) [194

National Central Library. 33rd Annual Report of the Executive Committee for the Year ending 28 February 1949. Pp. 32. (London: National Central Library, 1950.) [194

Department of Scientific and Industrial Research: Food Investigation. Leaflet No. 10: The Torry Research Station Controlled Fish-smoking Kiln. By Dr. C. L. Cutting. Pp. 16+4 plates. (London: H.M. Stationery Office, 1950.) 1*s*. 6*d*. net. [194

The Hydro-Electric Schemes of the British Electricity Authority for the North Wales National Park: The Case against the Schemes. Pp. 24. (Liverpool: North Wales (Hydro-Electricity) Protection Committee, 1950.) [194

Department of Scientific and Industrial Research: Building Research Station. National Building Studies, Bulletin No. 7: Sands for Plasters, Mortars and External Renderings. By A. D. Cowper. Pp. iv+19+3 plates. (London: H.M. Stationery Office, 1950.) 9*d*. net. [204

B.I.O.S. Survey's Report No. 29: Telecommunications and Equipment in Germany during the Period 1939–1945. Prepared by the General Post Office. Pp. 55. (London: H.M. Stationery Office, 1950.) 1*s*. 6*d*. net. [204

Institute of Physics. Notes on the Preparation of Contributions to the Institute's Journal and other Publications. Pp. 32. (London: Institute of Physics, 1950.) 2*s*. [204

Ministry of Fuel and Power. Reports of H.M. Inspectors of Mines for the Year 1948. North Western Division. Report by E. H. Frazer. Pp. 38+6 plates. (London: H.M. Stationery Office, 1950.) 1*s*. net. [204

Question. Edited by H. Westmann. Vol. 2, No. 3: Man's Creativeness? (Published for the Present Question Conference, Ltd.) Pp. 277–368. (London: Hammond, Hammond and Co., Ltd., 1950.) 2*s*. 6*d*. [204

History of the Primates: an Introduction to the Study of Fossil Man. By Prof. W. E. Le Gros Clark. Second edition. Pp. v+117. (London: British Museum (Natural History), 1950.) 2*s*. 6*d*. [244

British Standard 1638: 1950. Report on the Selection of Ranges of Types and Sizes (Preferred Numbers). By J. E. Sears. Pp. 32. (London: British Standards Institution, 1950.) 3*s*. net. [244

A Problem in Chemical Engineering Design: the Manufacture of Mononitrotoluene. Revised and prepared for publication by J. M. Coulson and F. E. Warner. Pp. 56. (London: Institution of Chemical Engineers, 1949.) 15*s*. 6*d*. [244

Institution of Chemical Engineers and Society of Chemical Industry Road and Building Materials Group. Symposium on Particle Size Analysis, February 4, 1947. (Supplement to Transactions, Institution of Chemical Engineers, Vol. 25, 1947.) Pp. ii+145. (London: Institution of Chemical Engineers, 1947.) 42*s*. [244

Journal of the Imperial College Chemical Engineering Society. Vol. 4, 1948. Pp. 207+xix. (London: Imperial College of Science and Technology, 1948.) [264

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